COMPUTATION OF TRUE MOON

BY

MĀDHAVA OF SAṄGAMAGRĀMA

सङ्गमग्राम-माधव-कृता

स्फुटचन्द्राप्तिः

Ed. K. V. SARMA

VISHVESHVARANAND INSTITUTE

HOSHIARPUR

The *Sphuṭacandrāpti* of Mādhava, edited here for the first time from its only known manuscript, enunciates an easy and ingenious method which would enable the accurate computation of the the Moon at intervals of about 40 minutes each throughout the day. The Chart prepared for the above purpose is so designed that, with minor changes, it could be used for several days in succession.

The author, Mādhava of Saṅgamagrāma, is an astute astronomer of mediaeval Kerala (*c*. 1340-1425), who has several works to his credit. He is widely quoted by later astonomers of Kerala and is also reputed for his enunciation of formulae for the accurate determination of the circumference of a circle and the nature of π by the method of indeterminate *infinite* series, a method which was re-discovered in Europe about three centuries later by James Gregory (1638-75) and Wilhelm Leibnitz (1646-1716).

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MĀDHAVA OF SAṄGAMAGRĀMA

Critically Edited with Introduction,
Translation and Notes

By

K. V. SARMA
Reader in Sanskrit,
Vishveshvaranand Institute of Sanskrit
and Indological Studies

प्रथम संस्करण, २०३० वि.

प्रकाशक—विश्वेश्वरानन्द-संस्कृत-भारतभारती-अनुशीलन-संस्थान

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PREFACE

Introductory

The *Sphuṭacandrāpti* of the renowned mediaeval astronomer of Kerala, Mādhava of Saṅgamagrāma (*c.* A.D. 1340-1425), critically edited here for the first time, enunciates an ingenious method for the computation of the True Moon. Besides being the fastest *graha*, the Moon has also the maximum changes in its motion, with the result that its position if calculated on the basis of its position at sunrise and/or at sunset and its average motion for the day would give only rough results. Mādhava describes in the present work the construction of a Chart from which the True Moon could be read out at intervals of about 40 minutes each throughout the day. The Chart is also so designed that, with minor changes, it could be used for the succeeding days as well.

The Present Edition

The critical edition of *Sphuṭacandrāpti,* presented in the following pages, is based on its only available manuscript. For facilitating the comprehension of this technical treatise, an English rendering has been added on pages facing the text. In the foot-notes to the edition, an endeavour has been made to derive the several formulae enunciated by the author for the computation. The principles underlying the method have been set out in detail in the Introduction that follows this Preface. A concrete example has also been worked out in order to demonstrate the calculations.

Moon-sentences

For ensuring accuracy in the above, it is essential that the daily motion of the Moon used for the calculations is very accurate. The Moon-sentences of Vararuci, which are ordinarily used in Kerala astronomical practice,[1] are correct only to the minute and so can give only rough results. Mādhava has, therefore, computed in place of the above, more sophisticated Moon-sentences, correct to the second, for nine anomalistic cycles of the Moon (248 days) and set them out

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1. For a critical edition of these Moon-sentences called *Girnaḥ śreyādi Candravākyāni Vararuci-kṛtāni,* see *Vākyakaraṇa,* (Cr. ed. by T. S. K. Sastri and K. V. Sarma, K. S. Res. Inst., Madras-4, 1962), App. II, pp. 125-34.

in the form of a Table.   A critical edition of this Table, which begins with the sentence *śīlam rājñaḥ śriye*, has been added to the present edition as Appendix I.

Verification of the Sentences

The said Moon-sentences are *ad hoc* mnemonic expressions, independent of each other and having no contextual sequence. Quite often, they do not have any logical sense either. This nature of these sentences, apart from creating conditions for errors to creep in, also debars the correction of such errors with reference to the context or grammar. The same holds good *mutatis mutandis* in the verification of doubtful readings. Two methods have been enunciated in the manuscripts of these Sentences for the correction of errors and for the clarification of doubts. These methods have been duly noticed at the close of the edition of the Sentences and have been demonstrated by concrete examples.

Manuscript Material

Text : The present edition of *Sphuṭacandrāpti* is based on its only available manuscript which originally belonged to the collection of the Nampūtiri brahman house of Kūṭallūr Mana in S. Malabar (Kerala) and is now deposited in the Kerala University Oriental Research Institute and Mss. Library, Trivandrum, as its Ms. No. 1055-A. The work is inscribed in Malayalam script on the first two folios of this palm-leaf codex of Jyotiṣa works, $10\frac{1}{2}'' \times 2\frac{1}{4}''$, with 11 lines a page and about 45 letters per line. The mansucript is old and slightly damaged and the edges are all frayed. The writing is small, clear and inked. It has passed through the hands of a revisor whose corrections can be identified by their not being inked. The text presented is generally correct and free from errors. Besides the *Sphuṭacandrāpti*, which is catalogued as A, the codex contains the undermentioned works : B. *Muhūrtadīpaka* by Nārāyaṇa, son of Keśava ; C. *Muhūrtaratna* by Govinda ; D. *Ācārasaṅgraha* by Parameśvara ; E. *Ṣoḍaśakriyāvidhi* ; F. *Muhūrtapañcaśikā* ; G. *Ācāradarśana* and H. *Muhūrtāṣṭaka*.

Moon-Sentences : The edition of Mādhava's Moon-sentences (*Viliptādi-Candravākyāni*) is based on four independent manuscripts, called here A, B, C, D, all in palm-leaf, inscribed in Malayalam script. Of these, A, which is taken as the standard in this edition on account of its textual purity, and C belong to the Oriental Research Institute and Manuscripts Library, Kerala University,

Trivandrum, being Mss. Nos. MC. 595-A (catalogued as *Vilipiādi vākyanṅgal*) and C. 2297-C, an uncatalogued stray leaf at the end. Ms. B belongs to H. H. The Maharaja's Palace Collection, Trivandrum, and is inscribed on a few stray uncatalogued leaves at the end of Ms. No. 4116, *Dṛggaṇitakrama*. Ms. D occurs as the third work in a codex of astronomical works beginning with the *Pañcabodha* preserved in the private collection of Elamprakkoṭattu Mana, Eravoor (near Tripunithura, Cochin) and carries the inscription 'Kūṭallūr Meleṭattu *Pañcabodhādi*' indicating that it originally be-longed to the Nampūtiri house of Kūṭallūr Meleṭattu in S. Malabar.

Mss. A, B and D are complete, while C breaks off in the middle of the 31st *vākya*, the rest of the leaves being lost. All the manus-cripts exhibit minor differences from one another and sometimes present entirely different *vākyas*, but to the same import. Possibly, these variants go back to the author himself.

Appendices II and III

In continuation of the *Sphuṭacandrapti*, the text manuscript contains two short tracts. The first depicts the *Yuga-bhoga-dhruvas*. (Zero-corrections per aeon) of the planets correct to 1/60th of a second. These verses, have been taken from the *Grahacāranibandhana* of Haridatta[1] and seem to have been extracted here for some practical use an account of their forming an independent unit.

The second tract, which is more interesting, sets out large chunks of full days, ranging from 16,45,705 to 248 with their *dhruva* for the Moon correct to the second. These are obviously intended for the subtraction of days in chunks and correction of the results by the application of the corresponding *dhruvas* in the computation of the Moon. The *dhruva* of the last of these chunks, *viz.* 248 (*devaḥ prājño nūnam*), is given as $0^r—27°—43'—29''$, the mnemonic sentence therefor being *dhīro'lam bhasuro jñānī*. This mnemonic resembles closely the corresponding mnemonic of Mādhava's Moon-sentences, which reads as *dhīragīr bhāsurā*,[2] indicating the possibility of common authorship.

Both these tracts have been included in the present volume as Appendices II and III, in the form of Tables, with the numerical figures of the sentences duly set out against them.

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1. Cr. ed. by K.V. Sarma, (K. S. Res. Inst., Madras-4, 1954), pp. 3-4.
2. See Appendix I, below.

Sphuṭa—2

Sphuṭacandrāpti and Veṇvāroha

The well-known *Veṇvāroha* of the author[1] deals with the same subject as the present work, but in a better organised manner. It incorporates most of the verses of the present work, often in an improved form. It seems very likely that the author wrote the present work first and recast it later as *Veṇvāroha*. This deduction is substantiated from another source. Now, in the present manuscript after the natural closing of the work with the verse *śīlam rājñaḥ śriye* etc , are found, in continuation, the following lines :

'कान्तं कर्म'विहीनं सत् प्राक्फलं 'सदना'हृतम् ।

प्रहतान्मूलहीना[त्] स्वात् 'संसारा'न्तसमन्वितम् ॥

हित्वा लिप्तात्मकं राशिषट्काच्छिष्टं विषुन्तुवः ।

वाक्यसंख्यावशाद् वाक्यकालेष्वेष तद्कंवत् ।

प्रत्राद्योत्पत्तिकोऽस्त्येव वेण्वारोह इव क्रमः ।

द्युनिशोरविशेषेण द्वयोस्तत्पार्श्वयोरिव ॥

उपर्युपरि पूर्वस्माद् ध्रुवाः स्युः क्रमशः स्थिताः ।

वाक्यसंख्यास्तथाधोऽधो व्यत्ययो व्यत्ययाद् द्वयम् ॥

स्वोच्चतुल्यतनोस्तस्य पुनः शिशुतमा गतिः ।

निजनीचसमस्यातः परिपूर्ति व्रजत्यसौ ॥

'शश'हीना स्फुटः सा स्यादल्पाऽस्माल्लुब्धका'धिका ।

'तीर्थकाङ्ग्रा'न्मृगानीक'भक्तं भागादि तद् ध्रुवे ॥

'प्र'गुणात् 'स'गुणं स्वर्णं क्रमात् तद्वाक्यसंख्ययोः ।

नाडीषड्ढयन्तरे संका द्येका चकमुपर्यधः ।

प्रणम्य प्रणयाद्येनां साधवो माधवोऽस्म्यदः ॥

<div align="right">(corrected to माघवोऽस्मि वः)</div>

It may be seen that some of these lines are repetitions of earlier lines revised in the form in which they occur in the *Veṇvaroha ;* some of the lines depict new ideas not found in the present work, but pertinent to it and also find a place in the *Veṇvaroha*, thus confirming the suggestion that the *Veṇvaroha* in 75 verses is a revised version of the present work in 51 verses.

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1. Cr. ed. by K.V. Sarma, (Tripunithura, 1956), with the Malayalam commentary of Acyuta Piṣāraṭi.

Venvāroha Method for the Moon

The facile method enunciated by Mādhava for the computation of Moon seems to have caught the fancy of later astronomers who have pursued it further. They used fresh dates and revised figures for calculations and extended the method by introducing innovations with a view to securing greater accuracy. It has been possible for the present writer to identify the undermentioned texts of this genre, which are mostly anonymous.[1]

1. *Drg-Venvārohakriyā*, in 14 verses, beginning with *venvārohakriyā seyam drśānitā'trā likhyate*, an uncatalogued anonymous tract found inscribed on ff. 163-65 of Ms. 5867 of the Kerala University Oriental Res. Institute, Trivandrum.

2. *Venvārohāṣṭaka* by Putumana Somayāji, in 8 verses beginning with *'rūkṣo'yam kruddhitāsyo'nita-kalidivasāt*, again an uncatalogued tract found in three folios towards the close of Ms. 404 of the said Institute.

3. *Sūkṣmacandrasphuṭānayanam*, in 15 verses, beginning with *'tenāddhākṣepi sūryaḥ' kalir athā*, an anonymous tract found inscribed in some of the miscellaneous leaves at the end of a manuscript of *Venvāroha* in the private collection of the Eḷamprakkoṭattu Mana, Eravoor (Tripunithura, Kerala), with an incomplete commentary in Malayalam.

The two tracts noticed below, found in the same codex in the said miscellaneous leaves, are also related to the *Venvāroha* :

4. A short tract in 10 verses, beginning with *sūkṣmeṇa dhruva-samskārahārakeṇodayajanmanā*.

5. Another short tract in 8 verses, beginning with *dhīpatir-nalatulyo'nam 'śivadūtā'hatam dinam*.

It is proposed to bring out a critical edition of these tracts also, in due course, along with the *Venvāroha* of Mādhava.

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1. The identification of such works is a problem for the reason that these short tracts are, more often than not, found inscribed in stray leaves at the ends of manuscripts and are left uncatalogued as insignificant sets of verses which do not make up full-fledged texts. Quite often all unidentifiable tracts at the ends of manuscripts are clubbed together in catalogues under innocuous titles like *Gaṇitakriyā, Jyotiṣaviṣayaḥ* etc,

Mādhava, the Author

Among the several astute astronomers of Kerala of the middle ages, Mādhava of Saṅgamagrāma holds a position of eminence. Till recently, he was unknown to the scholarly world, especially outside his native land. He hailed from the village of Saṅgamagrāma, the modern Irinjalakkuda, near Cochin, in Central Kerala, the name of his house being *Iraññi ninna palli* to be identified with one of the two still existing houses in the village, named Iriññanavaḷḷi and Iriññārappaḷḷi. This information the author gives in his *Veṇvāroha* and is corroborated by his commentator Acyuta.[1] Mādhava was the teacher of Parameśvara, (A.D. 1360-1455), the promulgator of the *Dṛggaṇita* school of Kerala astronomy and is frequently quoted in the mediaeval astronomical literature of Kerala with the appellation of *Golavid* ('Adept in Spherics'). Thus Nīlakaṇṭha Somayāji (1444-1545 A.D.), while referring to Parameśvara in his *Āryabhaṭīya-Bhāṣya* says : *Parameśvaras tu ... Mādhavādibhyo 'Golavidbhyo' Gaṇita-gola-yuktīr api bālya eva samyag gṛhītvā ... .*[2] Acyuta Piṣāraṭi uses the same appellation for Mādhava in the introductory verse to his *Sphuṭanirṇaya : vande 'golavidaś' ca Mādhavamukhān* etc.

Works of Mādhava

The *Veṇvāroha*[3] depicting a facile method for the computation of the Moon and the Moon-sentences,[4] commencing with *śīlam*

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1. *Cf.* बकुलाधिष्ठितत्वेन विहारो यो विशेष्यते ।

गृहनामनि सोऽयं स्यान्निजनामनि माधवः ॥ (verse 13)

Com. in Malayalam . यातोरु विहारं बकुळाधिष्ठितत्वं कोण्टु विशेषिक्कप्पेटुन्नतु, इवन् गृहनामत्तिङ्कल् श्रवनाकुन्नतु । बकुळम् = इरञ्ज्ञ । विहारम् == पळ्ळि । 'इरञ्ज्ञ निन्न पळ्ळि' एन्नु इल्लप्पेरु । तन्टे नामत्तिङ्कल् माधवन् ।

On this, see K.V. Sarma, Introduction to his edn. of *Veṇvāroha.*, *op. cit.*, pp. 6-7.

2. Edn., *Trivandrum Sanskrit Series*, No. 185, p. 154. For other similar statements, see *ib.*, p. 75 ; *tac ca Saṅgamagrāmajena 'Golatattvavidā' Mādhavena pradarśitam*; p. 108 : *ata eva 'Golavidā' Mādhavena kṣepavatām sphuṭāpakramāna-yane gaṇitaviśeṣaḥ pradarśitaḥ*

3. Cr. ed. by K. V. Sarma, (Tripunithura, 1956), with the Malayalam commentary of Acyuta.

4. Ed. as Appendix I, below.

rājñaḥ śriye were the only works of Mādhava known till recently. It has been shown lately[1] that he is the author also of *Lagnaprakaraṇa* in six chapters, *Agaṇita*, an extensive work on the computation of planets, using novel methodologies and two short tracts entitled *Madhyamānayanaprakāra* and *Mahajyānayanaprakāra*. Still another work possibly composed by him is the *Golavāda*, which seems to have helped to stabilise his appellation as 'Golavid'. *Sphuṭacandrāpti*, edited here, is the latest addition to his works.[2]

Besides the said full-fledged works, a number of stray verses of Mādhava are quoted by later astronomers like Nīlakaṇṭha Somayāji, Nārāyaṇa, commentator of the *Līlāvatī*, Śaṅkara, commentator of *Tantrasaṅgraha* etc. One of his significant contributions to mathematics, known from these quotations, is his enunciation of formulae for the accurate determination of the circumference of a circle and the value of π by the method of indeterminate series, a method which was re-discovered in Europe nearly three hundred years later by James Gregory (1638-75 A. D.) and Gottfried Wilhelm Leibnitz (1646-1716 A. D.).[3] His *jīve paraspara-nyāya* contains the enunciation, probably for the first time in India, of the formula for the sine of the sum of two angles, sine (A+B)=sin A. Cos B + Cos A. Sine B. The study and interpretation, in terms of modern mathematics, of the enunciations of Mādhava in his stray verses and in his full-fledged works is bound to yield valuable results in the history of Hindu astronomy.

Date of Mādhava

Certain directions given in the *Sphuṭacandrāpti* give a general indication of its date of composition. Thus, for the calculation of the Mean Sun we are asked to subtract from the current Kaliday the

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1. See K.V. Sarma, 'Date of Mādhava, a little-known Indian astronomer', *Quarterly Jl. of the Mythic Society*, (Bangalore), 49 (1958-59) 183-86 ; Intro. to the editon of *Veṇvāroha*, pp. 8-9; *History of the Kerala school of Hindu astronomy*, (Hoshiarpur, 1972), pp. 51-52, 151.

2. In my *History of the Kerala school of Hindu astronomy, op. cit.*, pp. 32-33, 117, I had mentioned this text as an anonymous work related to the *Veṇvāroha* of Mādhava. However, a closer examination of the work with a view to editing it established its being an earlier work of Mādhava himself.

3. On this, see *History of the Kerala school of Hindu astronomy, op. cit.*, pp. 20-26.

khaṇḍa 15,02,008 and 5180 anomalistic cycles of the Moon. If there be further days, the number of such days has to be multiplied by the mean daily motion and added (verses 20-21). This would show that the work was composed about this time. This date would be 15,02,008 days (Kali 4112, A.D. 1010) *plus* 5180 anomalistic cycles of the Moon (390 years), *i.e.*, about 1400 A.D.

Mādhava's recently identified work, *Agaṇita*, also gives a clue to his date. Indicating the *śodhyābda-s* ('deductive years') for the computation of the planets, the author states :

<p style="text-align:center">1320</p>

<p style="text-align:center">शकाब्दात् 'नरलोको'नाद् राघवं्बार्धंःसुना कुजः ।</p>

<p style="text-align:center">1318</p>

<p style="text-align:center">'दिव्यलोको'ननीलाप्रेम् तत्त्वज्ञंभिजिते बुधः ॥</p>

<p style="text-align:center">1340</p>

<p style="text-align:center">'नवलोको'नसारङ्गंजंराप्ते गुरुभंवेत् ।</p>

<p style="text-align:center">1158</p>

<p style="text-align:center">'हेमपुण्यो'नशाकाब्दात् सार्वंगोवरेभ्ंटुगुः ।</p>

<p style="text-align:center">1301</p>

<p style="text-align:center">'यज्ञलोको'ननीतांशिधंमेंराप्ते शनिर्भवेत् ।</p>

<p style="text-align:center">1276</p>

<p style="text-align:center">'तीर्थप्रियो'नशाकाब्दाद् गन्धज्ञंभिजिते तमः ॥</p>

The 'deductive years' for the different planets Mars etc. are Śaka 1320, 1318, 1340, 1158, 1301 and 1276, corresponding to A. D. 1398, 1396, 1418, 1236, 1379 and 1354. In consonance with the principle of *śodhyābda-s*, these figures represent the largest number of years possible to be cut off for the different planets at the time when the work was written. The date of composition of the work would thus, be just ahead of the largest 'deductive year' mentioned, which in the present case, is A.D. 1418.

A clue to the date of birth of Mādhava is provided by that of his younger contemporary and pupil, Parameśvara who was born *c.* 1360.

From the above considerations Mādhava could be supposed to have lived between A. D. 1340 and 1425.

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K. V. Sarma

Vishveshvaranand Institute,
Hoshiarpur,
Independence Day,
August 15, 1973

INTRODUCTION

OBJECT OF THE WORK

The *Sphuṭacandrāpati* Mādhava enunciates an easy and ingenious method which would enable one to compute True Moon at intervals of about 40 minutes each, throughout the day. Now, amongst the celestial bodies, the Moon has not only the fastest motion, of about 13° per day, but also the greatest variation in motion. On account of this, True Moon for any specific moment if calculated by the rule of three using its true position and motion, at sunrise, as is generally done in the case of the other planets, cannot be expected to give correct results, the possibility of error being as large as 10 *vināḍikās*. Even if the calculation is done using its true position and motions at sunrise and sunset, the results obtained would still be far from accurate. Accurate results can be obtained only by the second or third differences, which, however, would entail inordinate labour. The method described in the present work obviates this labour and makes it possible to read out from a chart the True longitude of the Moon accurately at nine times a day, at intervals of a little over six and a half *nāḍikās* (2 hrs. 40 min.). From the True Moon at the quarter (40 min.) of these intervals, the True Moon at any moment falling within any such 40-minute-interval can be calculated by the rule of three, to get remarkably accurate results. The fact that calculations are made correct to seconds adds to the accuracy of the results.

PRINCIPLE OF THE METHOD

Certain peculiarities of the popular Moon-sentences (*Candra-vākyas*) of the Kerala astronomer *Vararuci* have provided the clue to our author for devising the method described here. The said sentences comprise of 248 expressions couched in the *Kaṭapayādi* notation and give the longitudinal positions of the Moon for consecutive days contained in 9 full lunar anomalistic cycles of 27 days, 33 *nāḍikās* and 16-24/55 *vināḍikās* each. These *Candravākyas* can be used from the moment when the anomaly is zero, *i.e.*, from the conjunction of the Moon and its Higher Apsis (*Candra-Tuṅga-yoga*),

which occurs at the end of every anomalistic cycle, which may be at any time of the day and not necessarily at sunrise.

At sunrise, say, on the current day, suppose a full days and b part-day have gone by since when the anomaly was last zero. This would mean that we can commence using the *Candravākyas*, one per day, from the moment which is exactly $(a+b)$ days before the current day. Now, let us consider a moment which is b day before the current day. Since b is only a fraction of a day, this Moment will fall in the previous day, its *nāḍi-vinaḍi* being the *same* as the moment of the end of the cycle a days ago. So, if we add to the Moon's *Dhruva* (zero correction) at the end of the cycle, the Moon-sentence equal to a, the result will be the True Moon (*Candra-Sphuṭa*) for that Moment on the previous day.

Now, the above argument will apply not only for the end-moment of the last cycle, but also for the end-moment of any cycle before that, the corresponding Moments being exactly $(a+b)$ days + 1 cycle, $(a+b)$ days + 2 cycles, $(a+b)$ days + 3 cycles etc. before *sunrise* on the current day, (*i.e.*, the end of the final *Kalidina*, for the current day). Only, for every additional cycle by which the moment is pushed backwards, a zero-correction of $3^{\circ}\text{-}4'\text{-}7\frac{2}{2}\frac{2}{3}''$, which is the *Dhruva* for one cycle, will have to be deducted.

For nine such previous zero anomalies (by the reckoning of which one full series of 248 days and 248 *Candravākyas* would be exhausted), True Moons can be obtained at nine Moments on the day previous to the current day, *i.e.*, the last day of the *Kalidina*. The intervals between consecutive Moments will be a little more than $6\frac{1}{2}$ *nāḍikās*, and a quarter thereof, for which the longitudes could be calculated by the rule of three, would be about 40 minutes.

If the true Moons at the nine Moments are required for the current day and the succeeding days, they could be had by adding the succeeding relevant *Candravākya* in place of the *vākya* first used. For this reason, when the Moments, *Vākyas* and True Moons for any day, during a 248 day period, have been calculated and duly entered in a Table, the Tables for the further days could be prepared with ease therefrom.

It is to be noted here that this method depends on the accident that an anomalistic cycle does not consist of a whole number of days,

ᵥ in which case, one would, again and again, be getting the same *longitude* and that for the same moment.[1]

It is again to be noted that, in order to secure a high degree of accuracy, the author has devised a new set of Moon-sentences, correct to the second, for use in the calculation of the Moon by the method set out in the present work,[2] in place of the commonly used *Candravākyas* of Vararuci which are correct only to minutes.[3]

METHOD OF WORKING

Dhruva-sādhana

In actual working, the author has introduced several ingenious innovations with a view to lighten the labour involved and to arrive at quick results. Thus, by calculating backwards, he has arrived at an Epoch (*Khaṇḍa-dina*), viz., *Kalidina* 15,02,008 (*dinanamrānuśasya*) (verse 5), at the end of which a conjunction of the Moon and its Higher Apsis (*Candra-Tuṅga-Yoga*) had occurred. Thus, an anomalistic cycle of the Moon commenced at sunrise, at the expiry of the said *Khaṇḍa-dina*, thereby removing the part-day, viz., b of (a+b) days (*vide supra*), and enabling calculations with full days.

For computing the True Moon on any particular day, subtract the above *Khaṇḍadina* from the *Kalidina* for that day and find out the number of completed anomalistic cycles which have gone by subsequent to the epoch. For this, the remaining days (*Khaṇḍa-śeṣa*) is asked to be multiplied by 6845 (*śivadūta*) and divided by 188,611 (*paryāptahṛdaya*), the underlying reason being that the period of a cycle is given by the fraction 138,611/6845 days which works out to 27 days, 33 *nāḍikās*, 16-24/55 *vināḍikās* (verse 5). The quotient is called the 'First result' (*Agrimaphala*). The further eight results are also noted by reducing the quotient progressively by 1, 2 etc.

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1. Of course this could be obviated by using, instead of the current *Vākyas*, new *Vākyas* constructed for ˌfractions of days and applying them appropriately.

2. For a critical edition of these Moon-sentences, which commence with *śilam rājñaḥ śriye*, see Appendix I, below.

3. For an edition of Vararuci's *Candravākyas*, see *Vākyakaraṇa*, Cr. ed. by T. S. K. Sastri and K. V. Sarma, (K. S. R. Institute, Madras—4, 1962), pp. 125-34.

These nine figures, which are termed *Dhruva-sādhana-s*, form the basis for the calculation of the *Dhruvas* etc. (verse 6),

Example :

Kalidina taken	$= 18,46,496$
Subtracting *dīnanamrānuśāsya*	$= 15,02,008$
Remainder (*Khaṇḍaśeṣa*)	$= 3,44,488$

No. of completed cycles or 'First result' (*Agrimaphala*)

$$= \frac{Khaṇḍaśeṣa \times śivadūta}{paryāptahṛdaya}$$

$$= \frac{3,44,488 \times 6845}{1,88,611}$$

$$= 12,502$$

Remainder $\quad = 5,638$

The nine *Dhruva-sādhanas* will be 12,502 ; 12,501 ; 12,500 ;... 12494.

Moon-sentence-Numbers (Vākya-saṅkhyā-s)

Next is to be ascertained the serial number of the *Vākya*, in the current anomalistic cycle, of the day taken, and those of the further eight Moments in the preceding eight cycles. Since the remainder left in the division for getting the full cycles gone by (verse 5) is really the number of days in the current cycle multiplied by 6845 (*śivadūta*), the said number can be retrieved by dividing the remainder by 6845. Again, since the preceding eight Moments will precede the first Moment successively by one full cycle each, their *vākya*-numbers can be ascertained by adding 1,88,611 to the respective remainders and dividing by 6845 and adding the quotient got to the immediately preceding *vākya*-number.

Example (contd.)	1	2	3	4	5	6	7	8	9
Remainders :	5638	2589	6385	3336	287	4083	1034	4830	1781
Vākya-numbers :	0	28	55	83	111	138	166	193	221

Zero-Moments (Dhruvakāla-s)

Now, the first Moment (*Dhruvakāla*) falls at *Remainder* / *śivadūta* days *before* sunrise of the current day, or, in other words,

$$1 - \frac{Remainder}{śivadūta} \text{ days, } i.e. \frac{śivadūta - Remainder}{śivadūta} \text{ days,}$$

$$= \frac{(6845 - Remainder)}{6845} \times 60 \text{ } nāḍikās = (6845 - Remainder)\frac{12}{1369} \text{ } nāḍikās$$

after sunrise on the previous day.   The preceding eight Moments will fall, similarly, at (6845—relevant Remainder) $1\frac{12}{369}$ *nādikās* (verse 8).

Example (contd.)

	Remainder	(6845—Remainder)	Moment
			na. vinā.
1.	5638	1207	10 35
2.	2589	4256	37 18
3.	6385	460	4 2
4.	3336	3509	30 45
5.	287	6558	57 29
6.	4083	2762	24 13
7.	1034	5811	50 56
8.	4830	2015	17 40
9.	1781	5064	44 23

Zero-Correction to longitudes (Dhruva-s)

Next is to be ascertained the Zero-corrections at the nine Zero-Moments (*Dhruvakāla-s*). The two items which go to make up these corrections are : (1) the Moon's longitude at epoch, and (2) the additional longitude due to the cycles which have gone by. For facilitating calculation, the author has isolated two lumps (*Khaṇḍas*) of cycles and indicated the corrections due to them : (i) 5105 (*māna-kāma*) cycles, the longitude due to which added to the zero-correction at the epoch, *viz.*, Kaliday 15,02,008 (*dīnanamrānuśāsya*), gives a result ending in complete minutes, being 5^r-24°-$47'$ (*sattvavān rāmaḥ*), and (ii) 69 (*dhṛti*) cycles, the longitude due to which, again ending in complete minutes, is 7^r-1°-$44''$ (*viśvaikanāthaḥ*).   For each additional cycle, the longitude is given as 3°-$4'$-$6\frac{22}{23}''$ (verse 10), which is 1/69 of 7^r-1°-$44''$ In actual practice, however, it is sufficient to calculate the correction for the First result (*Agrimaphala*, verses 5-6) ; Since the further eight results are successively 1 less than the First, their corrections can be had by diminishing the previous corrections by 3°-$4'$-$6\frac{22}{23}''$

Example (contd.)

The corrections, in the example taken, calculated as above would be :

(i)	6^r	13°	$12'$	$37''$
(ii)	6	10	8	30

(iii)	6ʳ	7°	4′	23″
(iv)	6	4	0	17
(v)	6	0	56	10
(vi)	5	27	52	3
(vii)	5	24	47	56
(viii)	5	21	43	49
(ix)	5	18	39	42

Table of Longitudes

The above results have now to be adapted for nine Moments in the Kaliday taken, in order to enable the corresponding longitudes to be read out with ease. For this the nine Moments are rearranged in the ascending order and posted in a table with the corresponding *Vakyas*, *Vakyasankhyas* and *Dhruvas* against each. The sum of the *Vakyas* and the *Dhruvas* will give the *Sphuṭa* (True longitude) of the Moon at the different Moments.

Table

Moment	Vākya-sankhyā	Vākya				Dhruva				True Moon			
nā. vina.		r	o	′	″	r	o	′	″	r	o	′	″
4 2	55	0	4	49	26	6	7	4	23	6	11	53	49
10 35	0	0	0	0	0	6	13	12	37	6	13	12	37
17 40	193	0	22	54	2	5	21	43	49	6	14	37	51
24 13	138	0	18	4	36	5	27	52	3	6	15	56	39
30 45	83	0	13	15	11	6	4	0	17	6	17	15	28
37 18	28	0	8	25	46	6	10	8	30	6	18	34	16
44 23	221	1	1	19	52	5	18	39	42	6	19	59	34
50 56	166	0	26	30	30	5	24	47	56	6	21	18	26
57 29	111	0	21	41	9	6	0	56	10	6	22	37	19

As instructed earlier, the above Chart can be re-adjusted to give the True Moon for the nine Moments on any other day if the *Vākya* for the required day is used in place of the *vākya* used here.

Corrections for the True Moon

The True Moon read out from the Chart would be correct only as reckoned from the zero meridian at Ujjain. It has, therefore, to be reduced to the local place, by the application of corrections for the Equation of time, Terrestrial longitude and Declensional Ascensional Difference, before the Chart becomes ready for use. These corrections are derived in the manner generally prescribed in astronomical manuals,

Correction for the Equation of Time (Bhujāntara-saṁskāra)

In the calculation of the Mean Sun (*Sūrya-madhyama*) required for this correction, the labour is lightened, again, by the use of a *Khaṇḍa*. It is instructed that for 5180 (*ādikūrma*) cycles, the Sun's *Dhruva* is 11^r-$11°$-$5'$-$11''$ (*karkaśānekakāryakṛt*). For the further completed cycles, it is $27°$-$9'$-$28\frac{9}{31}''$ each. That for the days etc. elapsed in the current cycle is to be found by multiplying the same by the Mean Daily Motion of the Sun, viz., $59'$-$8\frac{8}{47}$. The sum of these three would give the Mean Sun, which has to be calculated for the nine Moments (verses 22-23).

Exumple (*contd.*)	*Dhruva*
First result 12502	
Less 5180 (*ādikūrma*) cycles	11^r-$11°$-$5'$-$11''$
Remainder = 7322	
Dhruva for 7322 cycles at $27°$-$9'$-$28''$ per cycle	9 - 19 - 14-56
Do. at $\frac{9}{31}''$ per cycle	35-26
Vākyasaṅkhyā of the day = 0	
Sun's motion for $0° = 0 \times 59'$-$8\frac{8}{47}''$	0 0 0 0
Mean Sun at sunrise	9 - 0- 55- 33
Mean motion for the relevant Moment, viz., 10 *nā.*-35 *vinā.* $\times$ $59'$-$8\frac{8}{47}''$	10- 26
Mean Sun for First result	9 - 1 - 5- 59

The Mean Sun *minus* its Higher Apsis (*Mandocca*), viz., 2^r-$18°$ (*duṣṭā strī*) will give its *Kendra*. This *Kendra* is converted into arc and its sine read off from the of Table of sines. This divided by 160 will give the correction for the Equation of Time (*Bhujāntara-saṁskāra*) in *vināḍikās* (verse 24).

Correction for Terrestrial Longitude

The Correction for Terrestrial Longitude (*Deśāntara-saṁskara*) depends upon the east-west distance of the place in question from the Ujjain meridian which is to be known from tradition (verses 25-26).

Correction for Decl. Ascensional Difference

The R Sine of Sun-*plus*-precession in the sine table *guṇodyana* (153) etc. gives the Declensional Ascensional Difference (*cara*) in terms of *gurvakṣaras* for places where the equinoctial shadow measures two *aṅgulas*. For the place in question it will have to be derived from the above by the rule of three. The algebraic sum of these three corrections is now to be applied to the *Dhruva-kālas* (Zero-Moments) to get the *Vākya-kālas* (True Zero-Moments). The sum of the *Vākyas* and the corresponding *Dhruvas* will give the True Moon at these *Vākya-kālas* (True Zero-Moments) (verse 35).

The True Moons now recorded in the Chart are for intervals of just over six and a half *nāḍikās* (about 2 hrs. 40 min). The True Moons at one fourth these intervals might now be calculated by the rule of three posted in the chart so that the Moon at 40-minute intervals could be read out directly therefrom.

सङ्गमग्रामज-माधव-कृता

स्फुटचन्द्राप्तिः

COMPUTATION OF TRUE MOON

BY MĀDHAVA OF SAṄGAMAGRĀMA

सङ्गमग्रामज-माधव-कृता

स्फुटचन्द्राप्तिः

[मङ्गलाचरणम्]

[1]शिरश्शरणशीतांशुशिखानिष्यन्दिचन्द्रिकम् ।
अनकारहरं दिव्यं सिन्धुभूषं भजे महः ॥१॥

[ग्रन्थोद्देशः]

अधोऽधः क्रमशोऽतीतचन्द्रतत्तुङ्गसङ्गमात् ।
प्रत्यहं वाक्यनवकात् 'स्फुटचन्द्राप्ति'रुच्यते ॥२॥

श्रुतमात्रे प्रकारेऽस्मिन् न स्याद् यस्यातिविस्मयः ।
स्वस्यैवानधिकारेण स न गृह्णात्विमां गतिम् ॥३॥

[2]प्रणम्य प्रणये युष्मान् साधवो माधवोऽस्म्यदः ।
भवद्भ्यः प्रणतोन्नत्यै भवद्भ्यः किं न लभ्यते ॥४॥

[ध्रुवसाधनानि]

1502008
'दीननम्रानुशास्यो'नं दिनराशि कलेगतम् ।
  6845   188611
'शिवदूता'हतं हत्वा 'पर्याप्तहृदये'न यत् ॥५॥

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1. The Ms., Ker. Uni. 1055-A, begins with the words : हरिः
श्रीगणपतये नमः ।

2. This line occurs among the extra verses after the work as :

 प्रणम्य प्रणयाम्येनां साधवो माधवोऽस्म्यदः ॥

The last two letters have, later, been struck off and revise d t°स्मि वः ।

COMPUTATION OF TRUE MOON

By

MĀDHAVA OF SAṄGAMAGRĀMA

(Invocation)

1. I adore that divine effulgence (God Śiva), which removes the root cause of worldly extistence (*ana*), is adorned by the river (*viz.*, Ganges), and is shedding cool moonlight on account of the rays emanating from the moon ensconced in its crown.

(Object of the work)

2. (Herein below) is expounded the *Computation of True Moon* by means of placing, daily, one below the other, nine numerical expressions (*vākya-s*) as calculated from (the time of) the (previous) conjuction of the Moon and its Higher Apsis.

3. (Ifever there be) one who is not delighted on hearing about this method, let him not accept it. To be sure, he will not have the ability (to practise it).

4. Oh ! ye good souls ! I, Mādhava, bow before you and beseech you. For, what does not one obtain from you who are bent upon elevating those who bend before you.

(Dhruva-sādhana-s)

5-6. From the elapsed Kalidays (for any desired date) deduct (a *khaṇḍa*, lump number of days, equal to) 15,02,008 (*dīnanam-rānuśasya*). Multiply the remainder (*khaṇḍaśeṣa*) by 6845 (*śivadūta*) and divide by 1,68,611 (*paryāptahṛdaya*).[1] The quotient (got is

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1. Rationale : *Dīnanamrānuśāsya* (15,02,008) is a *Khaṇḍa* (Lump of days) at the end of which the Moon and its Higher Apsis are in conjunction *at mean sunrise* at Ujjain. This Lump can, therefore be discarded and calculations need be based only on the remaining days (*Khaṇḍaśeṣa*). Now, 6845 (*śivadūta*) anomalistic cycles of the Moon are contained in 1886.1 (*paryāptahṛdaya*) days. Hence the anomalistic cycles completed during the *Khaṇḍaśeṣa* is given by the expression :

$$\frac{Khaṇḍaśeṣa \times 6845}{188611}$$

लभ्यते तेन कर्तव्या वक्ष्यमाणविधेर्ध्रुवाः ।

तेनैवाद्यस्तथैकैकरहितेन तदष्टकम् ॥६॥

[वाक्यसंख्याः]

6845

शिष्टात् तु 'शिवदूता'प्ता वाक्यसङ्ख्याऽग्रिमा, ततः ।

188611

मुहुःप्रक्षिप्त पर्याप्तहृदया'त् क्रमशः पराः ॥७॥

[ध्रुवकालाः]

6845   12

पृथक् तच्छेषरहित'शिवदूता'त् 'प्रिया'हृतात् ।

1369

'घृतालय'हृता नाड्यो ध्रुवकाला इमे स्मृताः ॥८॥

[ध्रुवाः]

5^r–$24°$–$47'$ 5105

लिप्तादि 'सत्त्ववान् रामो' 'मौनकामे'ऽग्रिमे फले ।

7^r–$1°$–$44'$ 69

स च 'विश्वैकनाथ'श्च तस्मिन् 'धृति'युते ध्रुवः ॥९॥

called *Dhruva-sādhana* and) is to be used for deriving the several Zero-corrections (*Dhruvas*) to be used for calculations which will be enunciated below. The first *Dhruva* (is to be calculated) using this quotient itself (*Agrimaphala*), while the further eight (*Dhruvas*) are to be derived from this *Dhruva* reduced increasingly by 1.

(Moon-Sentence-Numbers)

7. Divide the remainder (in the division in 5) by 6845 (*śivadūta*). The quotient obtained will be the first Moon-Sentence-Number (*Vākyasaṅkhya*).[1] The further (eight Sentence-numbers can be obtained) in the same manner from the division by 6842 (*śivadūta*) of the successive remainders to which 1,88,611 (*paryāptahṛdaya*) has been added.

(Zero-Moments)

8. Subtract (each of the nine) remainders (obtained in 7) from 6845 (*śivadūta*). Multiply the (nine) balances by 12 (*priya*) and divide by 1369 (*dhṛtalaya*). The (nine) results obtained will be in *nāḍikās* and are (to be called) Zero-Moments (*Dhruvakāla-s*).[2]

(Zero-Corrections)

9. At the end of 5105 (*mānakāma*) (cycles) of the first (*Dhruva-sādhana*, *viz.*, the *Agrimaphala* of 5-6), the Zero-correction, beginning with minutes, is 5^r—24°—$27'$ (*sattvavān rāmaḥ*). For each increase of

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1. *Rationale* : The remainder (of the division in 5) is, in fact, the number of days in the current anomalistic cycle *multiplied* by 6845 (*śivadūta*) ; hence the division of this remainder by 6845 to get days. It may be noted here that since $\frac{188611}{6845}$ =27 days, 33 *nā.*, 16 *vinā.*, the further *Vākyasaṅkhyās* will successively increase by 27 or 28.

2. *Rationale* :

$$\frac{\text{Remainder (in verse 5)}}{6845} \text{ days} = \text{Remainder} \times \frac{60}{6845} \text{ } nāḍikās$$

$$= \text{Remainder} \times \frac{12}{1369} nāḍikās.$$

<div align="center">

3   4

ततोऽधिकं तु तत्रांशा 'गो'गुणा, 'वि'गुणाः कलाः ।

7   23

'सु'गुणा विकलास्तासु तद्'गौरां'शं विशोधयेत् ॥१०॥

</div>

[परितालिका]

साधयित्वा ध्रुवांश्चैव ध्रुवकालांस्तथानयेत् ।

आद्यमल्पतमं कृत्वा यथाऽधिकतमोऽन्तिमः ॥११॥

तैः सार्धं तत्र तत्र स्युः सह तद्वाक्यसंख्यया ।

तद्ध्रुवा स्वार्कमध्याय स्वसाधकफलान्विताः ॥१२॥

[1]अत्राप्यौत्पत्तिकोऽस्त्येव वेण्वारोह इव क्रमः ।

द्युनिशोरविशेषेण द्वयोस्तत्पार्श्वयोरिव ॥१३॥

उपर्युपरि पूर्वस्माद् ध्रुवाः स्युः क्रमशः स्थिताः ।

वाक्यसंख्यास्तथाघोऽधो, व्यत्यये व्यत्ययाद् द्वयम् ॥१४॥

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1. Verses 13-14 occur among the extra verses after the close of the work. They are editorially inserted here in consonance with their sense and similar occurrence in this context in the *Veṇvāroha*, the revised version of the present work.

69 (*dhṛti*) (cycles, thereafter), the increase in zero-correction is 7ʳ-1º-44′ (*viśvaikanātha*).[1]

10. (To get the *Dhruva* for) the remaining cycles, multiply the same by 3 (*go*), getting thereby degrees, by 4 (*vi*), getting thereby minutes, and by 7 (*su*), getting thereby seconds ; in the case of seconds, however, reduce them by 1/23 (of the number of the said cycles).[2]

(The Chart)

11. When all the *Dhruvas* have been calculated (as instructed in 9-10) and so also the *Dhruva-kālas* (as instructed in 8), arrange them in (the ascending) order, so that the smallest (*Dhruvakāla*) comes as the first and the largest as the last.

12. Alongside each (of the *Dhruvakālas*), chart the corresponding *Dhruvas* with their respective *Vākyasaṅkhyās*. Chart also the *Phalas* which enabled the calculation (of the above), for use (later) in the computation of the Mean Sun.

13-14. Here (in the chart of verses 11-12, above), there will be apparent a natural order, irrespective of (the two) sides of the day, *viz.*, day and night, as in climbing a bamboo tree (wherein the branches will be found equally distributed on its two sides). Thus, the

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1. *Rationale* : 5105 (*mānakāma*) anomalistic cycles are chosen in such a manner that their *Dhruva* added to the *Dhruva* of the *Khaṇḍa* 15,02,008, (*dīnanamrānuśāsya*) ends in full minutes and not be carried forward to seconds. 69 (*dhṛti*) is the least number of anomalistic cycles for which, too, the *Dhruva* will end in full minutes.

It has to be remembered, in this connection, that the *Dhruva* 5ʳ-24º-27′ (*sattvavān rāmaḥ*), includes in it the *Dhruva* of the elapsed *Khaṇḍa* also. Therefore 5105 (*mānakāma*) cycles should be reduced from the *Agrimaphala* only once, even if it is possible to reduce it by 5105 more than once. For further reductions, 69 (*dhṛti*) and its *Dhruva* alone should be made use of.

2. *Rationale* : For *dhṛti* (69) *Kendra* cycles, the Moon's *Dhruva*= *dhṛti* (69) + *viśvaikanātha* (7ʳ-10º-44′). *Dhruva* for 1 cycle =

$$\frac{dh\underset{.}{r}ti + vi\acute{s}vaikan\bar{a}tha}{dh\underset{.}{r}ti} = \frac{69^s\text{-}7^r\text{-}1°\text{-}44'}{69}$$

$$= 1^s\text{-}0^r\text{-}3°\text{-}4'\text{-}6\frac{22''}{23} = 1^s\text{-}0^r\text{-}3°\text{-}4' - \left(7 - \frac{1}{23}\right)'',$$

from which the completed 1 circle could be dropped.

प्रमुष्टसम्प्रदायस्य प्रक्रियेयमुदीरिता ।
तत एवाञ्जसाऽमीषां भवत्यवगमोऽन्यथा ॥१५॥

एकस्मिन् ध्रुवकाले या वाक्यसङ्ख्याऽवकल्पते ।
'शश'हीना पुनः सा स्यात्, न चेत् स'गुलिको'ऽनियोः ॥१६॥

55   193

3176   1035   2   7
'तीर्थकाङ्क्षा'त् 'मृगानीकैः' 'प्र'गुणात् 'सु'गुणाच्च यत् ।
विभज्य लब्धं भागादि धनर्णं तद् ध्रुवेऽस्तु तत् ॥१७॥

ध्रुवकालोऽपि येनैकः साध्यते तदनन्तरम् ।
ततः 'सर्वार्थं'युक्तेन' 'दीनदान'युतेन च ॥१८॥

747   808

अस्मिन्ननन्तरातीते समस्तं तद्विपर्ययात् ।
एकद्वित्र्यन्तरे कार्ये कर्तव्यस्तत्समुच्चयः ॥१९॥

'नाडीषष्ट्यन्तरेऽप्येवं सैका व्येकाऽथवा भवेत् ।
वाक्यसंख्या, ध्रुवो नान्यः, सा गतिः सार्वलौकिकी ॥२०॥

---

1. This and the next two lines occur in a slightly different form among the extra verses after the work, as :

55   193
'शश'हीना स्फुटः सा स्यादल्पास्मात् 'लुब्धका'विका ।
3176   1035
'तीर्थिकाङ्क्षात्' 'मृगानीक'भक्तं भागादि तद्ध्रुवे ।
2   7
'प्र'गुणात् 'स'गुणं स्वर्णं क्रमात् तद्वाक्यसंख्ययोः ॥

2. For युक्तेन the ms. reads हीनेन, which is wrong. The emendation is based on the parallel verse in the author's *Veṇvaroha*.

3. This line occurs among the extra verses after the work, as :

नाडीषष्टयन्तरे सैका व्येका चैवमुपर्यधः ।

Dhruvas will be, in order, successively greater than the one before, the *Vakyasankhyas* being so in the descending order. If otherwise, the order will be reversed (in both).

15. This method of work has been spelt out for (the benefit) of one who has forgotten the tradition. Otherwise, one would have an easy understanding thereof from tradition itself.

16-17. When the *Vakyasankhya* for a (particular) *Dhruvakala* is considered, the *Vakyasankya* next to it will be less than it by 55 (*sasa*) or greater than it by 193 (*gulika*). The (*Dhruvas*) for these two (*viz.*, 55 and 193 days) will be given by 3176 (*tirthakanga*) divided by 1035 (*mrganika*) multiplied, respectively, by 2 (*pra*) and 7 (*su*). The results, which will be in degrees, are to be added to or subtracted from the previous *Dhruvas*.[1]

18. When a *Dhruvakala* has been calculated from a number (*viz.*, 6845 *minus* the remainder, *vide* verse 8), the subsequent (*Dhruvakala-s*) would have been derived from numbers increased by 747 (*sarvartha*) or 808 (*dinadana*).[2]

19. In the case of a succeeding (*Dhruvakala*), all (the above-said) corrections should be applied, inversely. In the case of those removed by one, two or three (intervening *Dhruvakala-s*), the *sum* of the (relevant) corrections (should be similarly applied).

20. Again, at 60 *nadikas* (after or before) a *Dhruvakala*, the corresponding *Vakyasankhya* will increase or decrease by 1. But the *Dhruva* will not change. Indeed, this is a universal rule.

---

1. *Rationale* : Now , $\dfrac{tirthakanga}{mrganika} = \dfrac{3176}{1035} = 3°\text{-}4'\text{-}6\ \dfrac{22''}{23}$,

which is the *Dhruva* for one anomalistic cycle (*vide* 10). Since one cycle is equal to $27\frac{1}{2}$ days, roughly, (*vide* verse 7), *Dhruva* for 2 cycles or 55 days =

$$2 \times \dfrac{3176}{1035} = pra \times \dfrac{tirthakanga}{mrganika}$$

Dhruva for 7 cycles or 193 days $= 7 \times \dfrac{3176}{1035} = su \times \dfrac{tirthakanga}{mrganika}$.

2. This is demonstrated in the example worked out in the Introduction above, p. 21, where the figures are : 460, 1207, 2015, 2762, 3509, 4256, 5064, 5811 and 6558.

[ध्रुवकालसंस्कारः]

इत्थं तथैव वाप्तेषु तत्तद्वाक्यध्रुवैः सह ।
ध्रुवकालेषु कार्योऽन्यः संस्कारः, सोऽभिधीयते ॥२१॥

[रविमध्यम्]

5180 11^r-$11°$-$5'$-$11''$

'आदिकूर्मे'ऽग्निमफले 'कर्कशानेककार्यकृत्' ।
अर्कमध्यं विन्निप्तादि विद्यात्, प्रतिफलं पुनः ॥२२॥

$27°$-$9'$-$28''$ 9   31

'दाराधीनसुख' तद्वत् तत्तद्'धी'घ्न'युगां'शयुक् ।
वाक्यसंख्यावशाद् भूयः तत्काले तद्दिनेऽपि तत् ॥२३॥

[भुजान्तरसंस्कारः]

तत्कालमध्यमार्कस्य स्वोच्चहीनस्य दोर्गुणात् ।
160
अधऊर्ध्वर्धिजात् स्वर्ण 'आतपा'प्ता विनाडिका: ॥२४॥

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4 (*Of opp. page*). *Rationale* : The *Dhruvakāla-s* have been reckoned as from mean sunrise at Ujjain. They should be reckoned from true sunrise of place, which depends on : (i) the Sun's equation of the centre, (ii) the reduction to the equator, (iii) the longitude of place, and (iv) the declinational ascensional difference (*carārdha*) at place for that day. Of these, item (ii) is neglected by earlier astronomers like Āryabhaṭa, and not given by our author in this work, following Āryabhaṭa, though he must have known its need. Item (i) is given here.

The equation of the centre is taken as 129' X R Sin *Manda-kendra* / 3438 (Āryabhaṭa) and the True Sun rises earlier or later, as this is negative or positive, at the rate of 1 *prāṇa* of time per minute of arc. Therefore, it is equal to R. Sin *Manda-kendra* X 129/ (3438 X 6) = R. Sin *Manda-kendra* / 160 in *vināḍikās*, and is additive for the first six signs of *Manda-kendra* and subtractive for the next six.

It may be noted that item (iii) is given in verses 25-26 and item (iv) in verses 27-32, below.

(Correction to the Dhruvakāla-s)

21. To the *Dhruvakālas* derived in this manner, along with their *Vākyasaṅkhyās* and *Dhruvas* (verses 16-20), or calculated in the manner enunciated before (verses 7-9), another correction has to be applied. That is stated hereinbelow.

(Mean Sun)

22-23. At the end of 5180 (*ādikūrma*) (anomalistic cyles) contained in the first result (*Agrimaphala*, being the first *Dhruvasādhana*, vide verses 5-6), the Mean Sun, correct to the seconds, is 11^r-11°-$5'$-$11''$ (*karkaśānekakāryakṛt*).[1] For each remaining (cycle) the Mean Sun is (to be calculated at the rate of) 27°-$9'$-$28''$ (*dāradhīnasukham*) plus $9/31''$ (*dhī/yuga*)[2] (and added). Again, (is to be calculated and added, the Mean Sun) for (the number of days equal to) the *Vākyasaṅkhyā* and for that portion of the day under consideration upto the time (of each *Dhruvakāla*).[3]

(The Correction for the Equation of Time due to the Equation of the Centre)

24. The sine of arc of the difference between the Mean Sun and (the Sun's) Higher Apsis (*viz.*, 2^r-18°, *duṣṭā strī*) divided by 160 (*ātapa*) would give *vināḍikās*.[4] These should be added (to the *Dhruvakālas*) if Sun *minus* Apsis (*Kendra*) is less than a half-circle (6^r) and subtracted if greater.

---

1. *Rationale* : 5180 (*ādikūrma*) is a certain number of anomalistic cycles, the Mean Sun for which period when added to the Mean Sun of the *Khaṇḍa* 15,02,008 (*dīnanamrānuśāsya*) gives a result in full seconds, *viz.*, 11^r—11°—$5'$—$11''$ (*karkaśānekakāryakṛt*).

2. *Rationale* : The Mean Motion of the Sun in one anomalistic cycle is

$$27^o\text{-}9'\text{-}28\frac{9''}{31}=dārādhīnasukham+\frac{dhī}{yuga}$$

3. The Mean Motion of the Sun for this calculation, as given in the author's *Veṇvāroha*, (verse 38), is $59'$-$8\frac{8''}{-7}$.

4. (See opposite page).

[देशान्तरसंस्कारः]

प्राक् पश्चात् समरेखायास्तथा देशान्तरोद्भवाः ।
तद्विदां सम्प्रदायाद्धि तदियत्तावधार्यते ॥२५॥

इयत्यो लिप्तिकाः स्वर्णमिन्दुमध्य इति स्थितौ ।
<div align="center">255   56</div>
व्यत्यस्यर्णधने तास्ताः 'शिशिर'घ्ना'स्तमो'द्धृताः ॥२६॥

[चरसंस्कारः]

स्फुटीकृत्य पुनर्भानुं सायनस्यास्य दोर्गुणात् ।
<div align="center">158</div>
'गुणोद्याना'दयो ग्राह्या गुणाश्चरदलाप्तये ॥२७॥

[गुणोद्यानादिचरज्याः]

153	305	457	607
गुणोद्यानं	मनोलीनं	समभिज्ञः	सनातनः ।
756	903	1048	1190
तृणासनं	लूनधनु	देवानीक	निधिव्ययः ॥२८॥

1329	1464	1595	1721
धरालयो	वीतभयो	मधुमान्यं	परार्थकृत् ।
1840	1953	2059	2156
नवोदयं	गुणाधिक्यं	धर्मनिष्ठा	क्षमापरः ॥२९॥

2245	2323	2391	2448
शिवरात्रि	गुरुगिरः	काळागरु	दिवाध्वरः ।
2493	2525	2544	2551
बन्धुवैरं	शिखिशिखा	भवः शूरः	कृशः स्मरः ॥३०॥

(Correction for Terrestrial Longitude)

25. Then again, the corrective (*vinādikas*), on account of the place (in question) being situated to the east or west of the central (Ujjain) meridian, (has to be calculated). Its measure (for the place) is to be known from the traditional knowledge of the learned.

26. Therefore, when the correction in minutes to the Mean Moon (for the place, as got by tradition) has been found to be additive or subtractive, the minutes are to be multiplied by 255 (*śiśira*) and divided by 56 (*tama*) and applied inversely as *vinādikās*.[1]

(Correction for Declinational Ascensional Difference)

27. The True Sun is then computed and the precession added. Its R Sine in the Sine Table (below) beginning with 153 (*guṇodyāna*) is then noted in order to compute the Declinational Difference (*Cara-dala*).

28-30. Sr. No.	Gurvakṣaras (2/5 second)			
(1-4)	153	305	457	607
(5-8)	756	903	1048	1190
(9-12)	1329	1464	1595	1721
(13-16)	1840	1953	2059	2156
(17-20)	2245	2323	2391	2448
(21-24)	2493	2525	2544	2551

---

1. *Rationale* : The sun rises at the rate of 10 *vinādikas* earlier or later, as the place is 1° east or west of the standard meridian and this is additive or subtractive, respectively, to get the true *Dhruvakāla*. Expert astronomers find this time by various means, and usually express it in terms of correction to the Mean Moon, which, obviously, is negative for the east, and positive for the west. This is transmitted through tradition to succeeding astronomers. This can be re-converted into *vinādikas* by multiplying the Moon's correction by 255 and dividing by 56. since the mean motion in 255 *vinādikās* is 56'. Since the correction-*vinādikās* and the Moon's correction are opposite in sign, the sign is asked to be reversed.

छाया वैषुवती यत्र द्व्यङ्गुला तत्र केवलम् ।
गुर्वक्षरात्मकमिदं विद्याच् चरदलं कृतम् ॥३१॥

ततो न्यूनाधिकायां तु तत् स्यात् तदनुपाततः ।
सायनेऽर्केऽजजूकादौ ज्ञेया तस्य धनर्णता ॥३२॥

तेषामेकविधत्वे स्यादेकीभूतानि तानि सः ।
भेद एकस्य[1] चेत्तस्य चापरैक्यस्य चान्तरम् ॥३३॥

त एते ध्रुवकालाः स्युर्वाक्यकालाः सुसंस्कृताः ।

15

चरार्धमात्रसंस्काराद् दिनार्धं 'शुक'नाडिकाः ॥३४॥

दिनमानाल्लधीयांसस्तेऽह्न्येव, निशीतरे ।

[चन्द्रस्फुटः]

तेषु स्वध्रुवयुक्तानि वाक्यानि स्फुटशीतगुः ॥३५॥

ततस्तदन्तरालेषु स भवत्यनुपाततः ।
तस्य तत्कालगमनं यतस्तद्द्वितयान्तरम् ॥३६॥

---

1. For एकस्य the ms. reads ऐक्यस्य and for चान्तरं at the end of the line it reads चापरं, both of which are wrong. The emendation is in consonance with the parallel lines in the author's *Veṇvaroha*.

31. It is to be noted that the above (table) gives the half-ascensional differences (*Cara-dala*) expressed in terms of *gurvakṣara-s* and pertain to a place where the equinoctial shadow is two fingers' breadh (*aṅgulas*).[1]

32. (When the equinoctial shadow of the place in question is) less or more than (2 *aṅgulas*), (the half-ascensional difference) will be proportional (to the shadow). Its positive or negative nature is to be understood from the Sāyana-Sun being in (the six signs) from aries (*ajādi*) or from libra (*jūkādi*).

33-34a. When the sign of all the three is the same, (the total correction) is their sum ; when one is different, (the total correction) is the difference between it and the sum of the other two. The *Vakya-kāla-s* duly corrected (as above) will be the (correct) *Dhruvakāla* (*True Dhruva-kāla-s*).

34b-35a. Fifteen (*śuka*) *nāḍikas* corrected merely by the half-ascentional difference will give (the length of) the half-day. Those (*Vākyakāla-s*) which are less than the length of the (full) day (*i.e.*, twice the half-day as found above) will fall during daytime and the other (*Vākyakāla-s*) will fall during night-time.

(True Moon)

35b-36. The sum of the (relevant) *Vākyas* (Moon-sentences) and the (relevant) *Dhruvas* will give the True Moon-s (at those *Vākyakāla-s*). The True Moon (for times) in between (two *Vākya-kāla-s*) will have be calculated by interpolation. The Moon's motion during an interval is the difference between the two (relevant) True Moons (and hence the said interpolation).

---

1. This would correspond to a region having a latitude of $9\frac{1}{2}°$, like Central Kerala, from where the author of this work hailed.

[इष्टकालस्फुटानयने मार्गान्तरम्]

221   220

'कठोरं' 'निष्ठुरं' चैके क्षिपन्त्यूर्ध्वं त्यजन्त्यधः ।

27   28

यथोक्तवाक्यसंख्यायां 'सुखं' 'दुःख'मतोऽन्यथा ॥३७॥

60

तदन्तरं   निहत्येष्टनाडचा 'नत'हृतं ततः ।

धनर्णं   विदधन्त्यूर्ध्वमधश्चादावथोदिते ॥३८॥

[इष्टकालरविस्फुटम्]

विदधीतैवमेवार्के   विदित्वास्य   गति स्फुटाम् ।

तथा तन्मध्यमे कृत्वा कुर्याद्वा तत्स्फुटक्रियाम् ॥३९॥

स्वर्णं   स्वोच्चोनमध्यार्ककर्किनक्रादिषट्कजा ।

1550

कोटिज्या'त्माशय'हृता गतिर्मध्यास्य तत्स्फुटा ॥४०॥

(Another method for True Moon at any time during the interval)

37. (Another method to derive the True Moon at any desired time is now stated. If the desired time is) later (than the *Vākyakāla* nearest to it), some add 221 (*kaṭhora*) to the *Vākyasaṅkhyā* and (if the desired time is) earlier, subtract from it 220 (*niṣṭhura*). Or perform the operation with 27 (*sukha*) and 28 (*duḥkha*), applied in the reverse order.[1]

38. Multiply the difference, *i.e.*, the rate of the daily motion of the *Vākya* got, by the desired time, in *nāḍikas*, and divide the product by 60 (*nati*). The result should be added to the Moon's longitude (of the relevant *Vākyakala*) if (the desired time) is later and subtractad if earlier.

(True Sun at desired time)

39. In the case of the Sun, too, (its True position at any desired time) can be computed using its True Motion. Computation of the True Sun can be done also by finding the Mean Sun (at the time) using its Mean Motion.

40. R Cosine of the Mean Sun-*minus*-Higher Apsis is to be divided by 1550 (*atmaśaya*) and the result applied to the Sun's Mean Motion, positively (when it is) in the six signs beginning with Cancer (*Karki*) and negatively in the six signs beginning with Capricorn (*Nakra*).[2] The True (Daily) Motion of the Sun is got.

---

1. *Rationale* : Subtraction of 27 from above or addition of 28 from below gives the mid-*vākya*, whose rate is taken as the average for the interval. This rate being for one day or 60 *nāḍikās*, the division by 60 is done. Addition of 221 is the same as subtraction of 27, and subtraction of 220 is the same as adding 28, the total being 248. Either can be chosen according to convenience.

2. *Rationale* : Since the Sun's equation of centre is proportional to the Sun's Sin *Manda-kendra*, the variation in it causing true daily motion is proportionate to the Cosine, and, therefore, zero at 90° and 270° of *Kendra*.

8   31

तत्फलं वा 'जनेना'दि गृहीत्वा स्व'युगां'शयुक् ।
विदधीत विलिप्तासु तद्वदेव घनक्षयौ ॥४१॥

10^r–27°–3'–10" 6^r–8°–56'–50"

'इष्टाङ्गनासखो निःयम्' 'निःशेषमदनार्तिनुत्' ।
भागमात्रगतेर्भानोः स्फुटद्वयमिदं विदुः ॥४२॥

10^r–25°–4'–25" 6^r–10°–55'–35"

'शौरीव नश्शिरोनम्यः' 'शूली शुष्मनिकेतनः' ।
इमौ तन्मध्यमौ ज्ञेयौ श्रीमदार्यभटोदितौ ॥४३॥

'स्वोच्चतुल्यतनोस्तस्य पुनः शिशुतमा गतिः ।
निजनीचसमस्यातः पूरिपूर्ति व्रजत्यसौ ॥४४॥

ध्रुवकालोक्तसंस्कारः सद्ध्रुवेषु तथेष्यते ।
सूर्यसंक्रमवाक्येषु सूक्ष्मद्युगतसिद्धये ॥४५॥

अहर्गणेऽप्ययं शक्यः कर्तुमुक्तविपर्ययात् ।
स हि तत्संस्कृतो नित्यं भवत्यर्कोदयाद् गतः ॥४६॥

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1. This verse occurs among the extra verses after the work and
has been inserted here in consonance with its parallel verse in the
author's *Veṇvaroha*.

41. Alternatively, take the reading for Sun-*minus*-Higher Apsis in the Sine Table beginning with *janena*.[1] Add to it 1/31 (*yugaṁsa*) of itself and apply the result, taken as seconds, to the Mean Motion of the Sun, its being positive or negative being the same as before, (*i.e.*, as stated previous verse). (The Sun's True Motion is got).

42. The two positions of the True Sun (in its course) correct to seconds, when its daily motion is exactly 1°, are 10^r-27°-3'-10" (*iṣṭāṅganāsakho nityam*), and 6^r-8°-56'-50" (*niśśeṣamadanārtinut*).

43. The Mean Sun-s at these positions are, according to Āryabhaṭa, 10^r-25°-4'-25" (*saurīva naś śironamyaḥ*) and 6^r-10°-55'-35" (*śūlī śuṣminiketanaḥ*).

44. When the (true) position (*Sphuṭa*) (of the Sun) is equal to its Higher Apsis, it will have the slowest motion. And, when it is equal to its Lower Apsis, it will have its fastest motion.

45. The corrections prescribed for the *Dhruvakalas* are to be (computed and) applied also to the mnemonics for the Sun's transits (from one sign to another) so that correct results might be obtained.

46. This correction can be applied inversely also to the *Ahargaṇa* (Total number of Kalidays up to the current day). When corrected in this manner, it will give the True *Ahargaṇa* which elapsed at sunrise (on that day).

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1. This is the table of the Mandajyās of the Sun enunciated in the *Grahacāranibandhana* of Haridatta (ed. K.V. Sarma, K.S.R. Institute, Madras, 1954, p. 19) :

8	17	25	33	41	49	57	64

(1-8) जनेन सत्येन मुखेन लिङ्गिना यवेन धावेन समेन वर्तनम् ।

72	78	85	91	97	102	107	112

(9-16) रसेन हासेन मदेन योधनं सुघेनु रत्नस्य सुनीप रूपक: ।

116	119	121	124	126	128	129	129

(17-24) तटस्य धान्यस्य परस्य भद्रक इचरस्य हारस्य धराप धारक: ॥

These are the Sun's equation of the centre for every 3$\frac{3}{4}$° of *Kendra* beginning from 0° to 90°. These are proportionate to Sin *Kendra*. When shifted by 90°, so as to begin from 90° onwards, these will be equal to the Cosines, and proportionate to the variations in the equation of the centre causing the true motion. Since the constant variation is 1/60 × (1+1/31) of 129', the instruction to take it as seconds etc.

[राहुः]

5161 87

र'कान्तं कर्म'विहीनं सत् प्राक्फलं 'सदना'हतम् ।

35 277

प्रहता'न्मूल'हीनात् स्वात् 'संसारा'प्तसमन्वितम् ॥४७॥

हित्वा लिप्तात्मकं राशिषट्काच्छिष्टं विधुन्तुदः ।

वाक्यसंख्यावशाद् वाक्यकालेष्वेष तदर्कवत् ॥४८॥

[ग्रन्थसमाप्तिः]

वदतेतावदेवेत्थं यन्मया नोक्तमन्तरा ।²

सिद्धं कृत्वा समक्षेपि समक्षेऽपि तदस्तु वः ॥४९॥

इति संक्षिप्य सन्देहान् हन्तुं हन्त सतः सताम् ।

केनचित् सुधिया ख्याता सन्मार्गे शशिनो गतिः ॥५०॥

12°-2'-35"

'शीलं राज्ञः श्रिये' कृत्वा प्राक् पुनर्येन निर्मितम् ।

विलिप्तादिकं वाक्यजातं येन तेनेयमारचि ॥५१॥³

[इति सङ्गमग्रामज-माधव-कृता

स्फुटचन्द्राप्तिः समाप्ता ।]

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1. Verses 47-48 occur among the extra verses at the close of the work and are inserted here as required by their sense and propriety.

2. For यन्मया नोक्तमन्तरा, the ms. reads, यन्मयेनान्तरान्तरा । The correction follows its parallel verse in the author's *Veṇvāroha*.

3. After this occur 7½ verses, obviously written by Mādhava himself, (see Preface, p. 10), 2½ of them being revised versions of verses in the text. The rest have been fitted into this edition on the basis of the parallel verses in the author's *Veṇvāroha*.

(Node)

47-48. The first result (*Agrimaphala* of verses 5-6) is reduced by 5161 (*kāntam karma*) and multiplied by 87 (*sadana*). From the result subtract 35 (*mūla*) and add to the remainder its 277th (*saṁsāra*) part. (The result obtained is in) minutes and is to be subtracted from 6^r to get (the position of) the Node. Its position for the (different) *Vakyakalas* is to be computed proportionately using the *Vakyasaṅkhyā-s* in the same manner as that prescribed for the Sun.[1]

(Conclusion)

49. Stating but this much and that in a succinct manner, possibly certain details might have been left out by me, at places, under the presumption that those (details) are (generally) known. May all those (details) be before your (mind's eye).

50. With a view to dispel the doubts of good men, the motion of the Moon has been set out in a proper manner, concisely, by a man of intellect (which I consider myself to be).

51. By the very same person who composed the set of Moon-sentences, beginning with *śilam rājñaḥ śriye* (12°-2'-35"), correct to the seconds, has this work, too, been composed.

(Thus ends

THE COMPUTATION OF TRUE MOON

by Mādhava of Saṅgamagrāma)

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1. *Rationale* : It is taken that the motion of the Node is (87+87/277) minutes per Moon's anomalistic cycle. At 5161 Moon's anomalistic cycles after the *Khaṇḍa-dina*, the *Kṣepa* for the Node is (35+35/277) minutes, negative. Hence the subtraction of 35. Since the Node's motion is retrograde, the total result is to be subtracted from the position of the Node at the beginning of Kali, which is 6 *rāśis*. The use of proportion for the days gone during the current cycle is obvious, the motion of the Node being uniform.

APPENDIX I

सङ्गमग्रामज-माधवकृतानि

'शीलं राज्ञः श्रिये'त्यादि

विलिप्तादि-चन्द्रवाक्यानि[1]

Vakya No.	Vakya	Rāśi[r]	Bhaga[o]	Kalā[′]	Vikala[″]
1.	शीलं राज्ञः श्रिये[2]	0	12	2	35
2.	धिगिदं नश्वरम्	0	24	8	39
3.	लोलः पुरुषो नार्याम्[3]	1	6	21	33
4.	तपस्वी वेदिकः स्यात्	1	18	44	16
5.	सेव्याळका किन्नरैः	2	1	19	17
6.	दीप्रो दिने भास्करः	2	14	8	28
7.	धर्मरम्यं सुराष्ट्रम्	2	27	12	59
8.	स्तनौ लीलानुकूलौ	3	10	33	6
9.	पुत्रादौ न विरागः	3	24	8	21
10.	शौरिः समर्थ एव	4	7	57	25
11.	दुष्टैर्देशोपद्रवः[4]	4	21	58	18

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1. This critical edition of the *Vākyas* is based on the following four independent mss. : A. Kerala Univ., Ms. No. MC 595-A ; B. Trivandrum Palace, No. 4116-B ; C. Ker. Univ., No. C. 2297-C ; D. Kūṭallūr Meleṭattu Mana Ms.

2. A. ये ; B. यः ; D शूली त्रिनेत्रोऽव्यात् । Some of the *Vākyas* in B and D are entirely different and represent different versions.

3. A. यिः ; B. यूं

4. A. for पद्रवः, A reads बभूव, a scribal error on account of similarity in the Malayalam script.

Vakya No.	Vākya	Rāśi[r]	Bhāga[o]	Kalā'	Vikalā''
12.	व्यग्रो जन: क्षुन्नाशे	5	6	8	21
13.	योगीइवरो निराशः	5	20	24	31
14.	शिखण्डी भवनेषु[1]	6	4	43	25
15.	नागो यानाधिपति:	6	19	1	30
16.	परिणयेऽङ्गनेच्छा	7	3	15	21
17.	कविकण्ठस्था कथा	7	17	21	41
18.	शीलसम्पद्यानन्द:	8	1	17	35
19.	श्रीर्विना न मुकुन्दात्	8	15	0	42
20.	निराधारोऽहिराज:	8	28	29	20
21.	कुबेरो विकटधी:	9	11	42	31
22.	स्तेनानां इवा विरोद्धा[2]	9	24	40	6
23.	दीर्घरिरंसुर्ना नाके	10	7	22	48
24.	वानरो[3] मधुपानाढच:	10	19	52	4
25.	धननिकरो निर्ययौ	11	2	10	0
26.	रोगे[4] धैर्यविपर्यय:	11	14	19	32
27.	स्थूलो गिरिश्चित्रकूट:	11	26	23	37
28.	स्तम्भमात्रो हि[5]	0	8	25	46
29.	धीरधीस्त्रिनेत्र:	0	20	29	29
30.	प्रपदो गुरोनम्यो	1	2	38	12
31.	छन्नो[6] माणवक: किम्	1	14	55	7
32.	गानगोष्ठी सुखाय	1	27	23	3
33.	काकुध्वनिनंकारात्	2	10	4	11
34.	तनुनं नगरे धी:	2	23	0	6

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1. D. स्मरगर्भा वनिता
2. B. निगेढा, corrupt.
3. A. रावणो, corrupt.
4. A. रोगो
5. B. मात्रोऽहि:
6. C Breaks off with this word.

Vākya No.	Vākya	Rāśi[r]	Bhāga[o]	Kalā[']	Vikalā['']
35.	शैला: पुष्पितनगा:[1]	3	6	11	35
36.	लोलो जलधि: किल	3	19	38	33
37.	धनी नरोऽङ्गनावान्[2]	4	3	20	9
38.	सर्वविद् व्यास: कवि:	4	17	14	47
39.	स्तेनेन द्रव्यनाश:	5	1	20	6
40.	सूर्यो[3] बलमाकाशे	5	15	33	17
41.	मनुष्यो मधुरात्मा[4]	5	29	51	5
42.	गानं नेष्टं विपत्तौ	6	14	10	3
43.	पर्वचन्द्रोऽहिग्रस्त:	6	28	26	41
44.	भोगेच्छालं प्रियेऽर्थे	7	12	37	34
45.	मागधो गीतरस:	7	26	39	35
46.	लीनो नागो[5] निकुञ्जे	8	10	30	3
47.	गामुक्षा न विरेजे[6]	8	24	6	53
48.	रवौ हरे:[7] सन्निधि:	9	7	28	42
49.	वर्णान् वागनुरुन्धे[8]	9	20	34	54
50.	भावे स्मरोऽङ्गनानां स्यात्	10	3	25	44
51.	गायत्री नास्तिकैर्निन्द्या	10	16	2	13
52.	धनं चोरो हरेन्नित्यम्	10	28	26	9
53.	धर्मं धिगनपायस्य	11	10	39	59
54.	धीगतिभं द्रूपेयस्	11	22	46	39
55.	क्षीराब्धो श्रिभृ:	0	4	49	26
56.	यमोऽयमन्तिके	0	16	51	51
57.	गौरी स्थाणोर्वरा:	0	28	57	23

1. A. नला:
2. A. -ङ्गना वा
3. A. सूर्य-
4. D. मधुराश:
5. A. लोनोऽनङ्गो
6. B. D. विरजेत्
7. B. हार:
8. A. वागनिरुन्धे

Vākya No.	Vākya	Rāśi^r	Bhāga°	Kalā'	Vikalā''
58.	गरळं नोपयुञ्ज्यात्	1	11	9	23
59.	गोमानलं गरीयान्	1	23	30	53
60.	सुग्रीवोऽनन्तनिष्ठः:[1]	2	6	4	27
61.	प्राज्ञो[2] रामो दैत्यारि:	2	18	52	2
62.	अशुभाशया नागा:	3	1	54	50
63.	चपल: कामपाल:	3	15	13	16
64.	वाग्मी तु वादरागी	3	28	46	54
65.	गङ्गा भागीरथ्यभूत्	4	12	34	33
66.	तपस्वीगतिरूर्ध्वम्	4	26	34	16
67.	जरद्द्वोऽनुद्यम:	5	10	43	28
68.	सूनुर्धर्माभरणम्	5	24	59	7
69.	गुणोऽसूया धनिष्ठु	6	9	17	53
70.	विकृता गौडरीति:[3]	6	23	36	14
71.	लघुनं मैथुनेच्छा[4]	7	7	50	43
72.	आनन्दमयो रस:	7	21	58	0
73.	कल्य: शिशुर्मनुज:	8	5	55	11
74.	दृढधीर्लब्धपद:	8	19	39	48
75.	लीना आपोऽम्बुनिधौ	9	3	10	3
76.	क्षामवारिस्तोयधि:	9	16	24	56
77.	भाग्यविरोध: क्रोधात्	9	29	24	14
78.	धरा हीनाश्रया नित्यम्	10	12	8	29
79.	जनोऽन्धो गह्वरो नश्येत्	10	24	39	8
80.	मुकुन्दान्मोक्ष उपेय:	11	6	58	15
81.	आ गोहीनोऽधिक: पटु:	11	19	8	30
82.	ज्ञानी गार्ग्याय[5]	0	1	13	0

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1. D. सुखी वनितानिष्ठ:
2. D. राज्ञो
3. D. [बा]लरीति:
4. D. गावोऽनुशासनस्था:
5. B. गार्गोऽद्यम्

Vakya No.	Vakya	Rāśi[r]	Bhāga[o]	Kalā[']	Vikalā['']
83.	कृपण: कौण्डिन्य:	0	13	15	11
84.	लोला दीपशिखा	0	25	18	33
85.	स्वर्गस्तु[1] प्रार्थनीय:	1	7	26	34
86.	सौम्रात्रं वाधिकं स्यात्	1	19	42	27
87.	लीनोऽलीनो[2] त्रिनेत्र:[3]	2	2	9	3
88.	धिगाह्वविकार:	2	14	48	39
89.	शिशिरा वासरश्री:	2	27	42	55
90.	अग्निरामा नकुली	3	10	52	40
91.	धर्मार्थ: पूर्वरङ्ग:	3	24	17	59
92.	मानुजो मिथुनेऽभूत्	4	7	58	4
93.	रौद्रो यमस्यारम्भ:	4	21	51	22
94.	धिगाशामशनेऽस्मिन्	5	5	55	39
95.	जनार्दनो नरेश:	5	20	8	8
96.	मृगा: शूरा वनान्ते	6	4	25	35
97.	चण्डो वं भोजपति:	6	18	44	36
98.	धीगम्भोऽनङ्ग एव	7	3	1	39
99.	धैर्यालय: सन्न्यासी[4]	7	17	13	19
100.	चन्द्रात्[5] तापापनोद:	8	1	16	26
101.	सेव्यो जनैर्मुकुन्द:	8	15	8	17
102.	अभिषवोऽहरह:	8	28	46	40
103.	कार्योऽनार्य[6]रुपधि:[7]	9	12	10	11
104.	मानदेयं मुरळी	9	25	18	5
105.	ज्वलनो यजने[8] नम्य:	10	8	10	34

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1. B. सु (wrong)   2. D. लीनोधीनो
3. B. लीनोळिनोत्र नेत्र   4. B.D. सन्न्यास:
5. B.D. चन्द्र: 6. B. नान्यै
7. B. —रविपति: (corrupt) ; D. कार्या नार्या रुअधी:
8. D. ज्वलनोऽयं जनै:

Vakya Na.	Vākya	Rāśi[r]	Bhaga[o]	Kala[ʹ]	Vikala[ʺ]
106.	क्रीडा दृढा नरनार्यो:	10	20	48	32
107.	विश्वं गोपाल एकाकी[1]	11	3	13	44
108.	फलाहारो मूल्यकल्प:	11	15	28	32
109.	धन्वी शूली सुरः पूज्य:	11	27	35	49
110.	गोमवो गळो[2]	0	9	38	53
111.	धनुर्ज्या विपाठा[3]	0	21	41	9
112.	आढच: षड्भागेनृप:	1	3	46	10
113.	धन्य:[4] स्थाणुमुपेयात्	1	15	57	19
114.	धिगसौह्यं हिरण्यात्	1	28	17	39
115.	देवो धावन्नेकत्र	2	10	49	48
116.	तन्वी शीलगरिष्ठा	2	23	35	46
117.	लक्ष्मीस्तुङ्गस्तनाङ्गी	3	6	36	53
118.	चला लक्ष्मीर्धन्यगा	3	19	53	36
119.	धिगश्रीव्रगा नाव:	4	3	25	39
120.	पूर्ण: पयसा कुम्भ:	4	17	11	51
121.	कठिनोऽयं कीनाश:	5	1	10	21
122.	धिगहुंयुमकस्मात्	5	15	18	39
123.	षड्भागबन्धुरोश:	5	29	33	46
124.	कठोरो मृगपति:	6	13	52	21
125.	क्षीणो न व्याहरति	6	28	10	56
126.	धर्मशास्त्रं श्रेयसे[5]	7	12	25	59
127.	लोकोऽभिलाषी रसे[6]	7	26	34	13
128.	सागरो गोनं पदम्	8	10	32	37
129.	रविजुष्टं वारिजे[7]	8	24	18	42

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1. D. विभुर्गोपालनायक:
2. B. गळौ
3. B. विपरी
4. B. धन्या
5. B. धीमान् मुरारिव्यास:
6. B. लाषिरसौ
7. B. रविजो युवराज;

Vakya No.	Vakya	Rāśi[r]	Bhāga[o]	Kalā[']	Vikalā['']
130.	साम्बोऽनिशं सन्नद्धः	9	7	50	37
131.	प्रत्यासन्न: पुरोधाः	9	21	7	12
132.	इष्टिदर्शं विना नेष्टा	10	4	8	10
133.	नानामिमतं कनकम्	10	16	54	0
134.	श्रीनतः श्रीधरो निश्यम्[1]	10	29	26	2
135.	सुकृतिः स्वयं पाककृत्	11	11	46	17
136.	काष्ठसमा गात्रयष्टिः	11	23	57	21
137.	अरिरनाप्तः	0	6	2	20
138.	चण्डमानुजयी	0	18	4	36
139.	व्यवच्छिन्नोऽनुनयः[2]	1	0	7	41
140.	कीनाशो व्याघ्रकल्पः	1	12	15	1
141.	वाङ्माधुरी वरेण्या	1	24	29	54
142.	श्रीकृष्णो मोक्षनिष्ठः	2	6	55	12
143.	हृष्टो लीलाधिकारी	2	19	33	18
144.	स्वामी शरीरेऽनिलः	3	2	25	54
145.	स्थाणुर्गङ्गाशयालुः	3	15	33	57
146.	तेलार्थी मन्दरोगी[3]	3	28	57	36
147.	स्थानाच्चला रिपवः	4	12	36	7
148.	विनोदरुचिः प्रभुः	4	26	28	4
149.	साध्यो योगो नियमात्[4]	5	10	31	17
150.	पत्नी गर्भमरणा	5	24	43	1
151.	स्तेनो न निर्धनंषी	6	9	0	6
152.	सेनाधिकाङ्क्षरक्षा	6	23	19	7
153.	श्रीगीतालसा नासीत्	7	7	36	32
154.	धर्माज्जीवेत् परासुः	7	21	48	59

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1. B. रत्नचक्रधरा नार्यः   2. B. छिन्नेऽननयः

3. A. रोग;   4. D. योगनियम;

Vākya No.	Vākya	Rāśi[r]	Bhāga[o]	Kalā[']	Vikalā['']
155.	धनी गुणी मनुजः	8	5	53	9
156.	परिषस्त्वधिकेहा	8	19	46	21
157.	दिव्यः क्षीराम्बुनिधिः	9	3	26	18
158.	धीरः कर्णस्तु योढा	9	16	51	29
159.	तनयो ज्ञानिनां नम्यः[1]	10	0	1	6
160.	गोकर्णमित्रं पिनाकी	10	12	55	13
161.	प्रमवो गुणरत्नाढचाः	10	25	34	42
162.	प्रकृत्यास्सनन्द उत्पाद्य:	11	8	1	12
163.	अनसूया निरपाया[2]	11	20	17	0
164.	जिष्णु[3]र्वरिष्ठः	0	2	24	58
165.	दिश्यादिन्द्रो भाग्यम्	0	14	28	18
166.	नगो न गोचरत्[4]	0	26	30	30
167.	गानशीलो जनोऽयम्	1	8	35	3
168.	पुराणो[5] भानुरीडच:	1	20	45	21
169.	बालोऽसून्नीलनेत्रः	2	3	4	33
170.	जटी शूली शङ्करः	2	15	35	18
171.	प्रवृद्धोऽयं जाठरः[6]	2	28	19	42
172.	सन्निधौ स्यात् कपाली[7]	3	11	19	7
173.	दीनेश्वीडा विफला	3	24	34	8
174.	बाल्येऽवज्ञो[8] जनो वं	4	8	4	13
175.	सौम्यधी: स्वयं प्रभुः	4	21	49	17
176.	बालास्तु वाग्मिनोऽमी[9]	5	5	46	33

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1. A. नेयो ज्ञानिना नम्य: (corrupt) 2. D. नूनं सत्येन श्रेय(:)स्या(त्)

3. D. विष्णु 4. D. गोचर:

5. B. पुराणे 6. D. प्रवृद्ध: कुञ्जरेन्द्र:

7. D. सन्नद्धोऽयं कपिल: 8. B. खाण्डवघ्नो

9. B. वाशाह्विनोनं (corrupt) ; D. स्वामीनोऽमी

Vakya No.	Vakya	Rāśi[r]	Bhāga[o]	Kalā[′]	Vikalā[″]
177.	शशलक्ष्माधिकांशु:	5	19	53	55
178.	सुखदं नवनीतम्[1]	6	4	8	27
179.	धन्वन्तरिर्जयति	6	18	26	49
180.	वागीशो वारनाथ:	7	2	45	34
181.	फलज्ञानेच्छा[2] कथम्	7	17	0	32
182.	धान्ये[3] न कस्यानन्द:	8	1	10	19
183.	शमधना: शापदा:	8	15	9	55
184.	चारार्थी महाराज:	8	28	57	26
185.	सोमोऽनङ्गारिव्याध:[4]	9	12	30	57
186.	मर्त्यो धन्वा शरधी:[5]	9	25	49	15
187.	शशी कुमुदिनीनम्य:	10	8	51	55
188.	रुद्रो धीगम्य: प्राज्ञ: स्यात्[6]	10	21	39	22
189.	ईशप्रियो[7] विनायक:	11	4	12	50
190.	विद्योज्ज्वला तार्किकस्य[8]	11	16	34	14
191.	धनाप्ताभूद्द्रिकन्या[9]	11	28	46	9
192.	दुर्गेयमनिन्द्या	0	10	51	38
193.	प्राज्ञौ विष्णुरुद्रो[10]	0	22	54	2
194.	पद्माक्षी शोभनास्या	1	4	56	51
195.	मर्गो[11] गोनाथ: पूज्य:	1	17	3	34
196.	हरि: सेव्यो धरया[12]	1	29	17	28
197.	पौलस्त्यो भयङ्कर:	2	11	41	31

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1. B. D. सत्राजिन्न विनीत: 2. D. पयस्यनिच्छा

3. B. धान्ये: ; D. धन्यै:   4. B. –रिव्यधि: ; D. सुमनोङ्गेरू···

5. D. मुकुळाभा मुरळी   6. D. प्रारब्धं लङ्क्रेन्द्रनाट्यम्

7. B. रङ्गप्रियो   8. B. ज्वलस्तु ···

9. D. धनुषा भेदो रिपो: स्यात्   10. D. प्रज्ञावान् मुरारि:

11. B. स्वर्गो   12. B. धरायाम्

Vākya No.	Vākya	Rāśi[r]	Bhāga[o]	Kalā'	Vikalā"
198.	स्थाने जयो वरिष्ठः[1]	2	24	18	7
199.	मानधनः सानुगः[2]	3	7	9	5
200.	तरुणः को न रागी	3	20	15	26
201.	गौरी सलीला न वा	4	3	37	23
202.	करीभव्योऽसौ युवा[3]	4	17	14	21
203.	तमस्विनीयं निशा	5	1	4	56
204.	रत्नासनमुपेमः	5	15	7	2
205.	हेम सम्पद्धारिणाम्[4]	5	29	17	58
206.	जडो विडम्बयति	6	13	34	38
207.	सलिलाशा सम्प्रति	6	27	53	37
208.	गुरुकार्ये[5] प्रयासः	7	12	11	23
209.	पाण्डवाः प्राप्तरथाः	7	26	24	31
210.	शिवधीरनापदे[6]	8	10	29	45
211.	चापी वीरो द्विरदे[7]	8	24	24	16
212.	शश्वन्मौनीजनोऽन्धः	9	8	5	45
213.	मूलं फलाढचश्राद्ध.[8]	9	21	32	35
214.	तमालामो घनो नित्यम्	10	4	43	56
215.	प्रभोर्धिगच्छकनकम्[9]	10	17	39	42
216.	वैश्वानरं नानुयायात्	11	0	20	44
217.	रागादिवैराग्यं पश्यम्	11	12	48	32
218.	श्रीरामनाम रम्याग्रचम्[10]	11	25	5	22
219.	प्रज्ञावान् पार्थः	0	7	14	2

1. D. पर्वेन्दुः पर्वरात्रिः
2. D. मानाधिनाथो नागः
3. D. करभः पाथेयवान्
4. B.D. धारिणः
5. D. काव्ये
6. B. धीरा नापदो
7. D. तपस्वी प्रवरो हि
8. B. श्रृङ्गीरङ्गीपरुद्धम्
9. D. प्रवाळेऽल्पासिकनकम्
10. D. श्रीरामो नामरकल्पः

Vakya No.	*Vakya*	*Rāśi*[r]	*Bhāga*[o]	*Kalā*'	*Vikalā*''
220.	बीभत्सुर्योधोऽयम्[1]	0	19	17	43
221.	ग्रामाधिप:[2] कनकी[3]	1	1	19	52
222.	धम्मिल्ले फुल्लपुष्पम्	1	13	23	59
223.	कालो बली शरण्य:	1	25	33	31
224.	तुङ्गयशसो नरा:	2	7	51	36
225.	धर्मज्ञा: प्राङ्नरेन्द्रा:	2	20	20	59
226.	दीर्घाङ्घ्रो नीलनाग:	3	3	3	48
227.	फलाढ्यो ऋतुकाल:	3	16	1	32
228.	केशवो योद्धा रङ्गे	3	29	14	51
229.	सौबलो वरयुवा	4	12	43	37
230.	पद्मेषु रन्ता रवि:	4	26	26	51
231.	भ्रमरश्रीनिकामम्	5	10	22	52
232.	तपोधरा: स्वैरिण:	5	24	29	16
233.	श्राद्धो गोविन्द एष:	6	8	43	10
234.	षट्[4]काव्यज्ञोऽम्बरीष:	6	23	1	16
235.	उद्यानं स्त्रीसनाथम्	7	7	20	10
236.	दीपतैलं पात्रस्थम्	7	21	36	18
237.	सूर्योऽस्तु वो मानद:[5]	8	5	46	17
238.	भानु: सर्वाधिको हि	8	19	47	4
239.	पीनोत्तुङ्गाङ्घ्रो नळ:	9	3	36	1
240.	हीनपाप: सुयोद्धा	9	17	11	8
241.	सूनु: कुलीनोऽनुनेष:	10	0	31	7
242.	तरुणो[6] बलीयानाढ्च:	10	13	35	26

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1. D. वि(व)रसा: काळिय:
2. B. ग्रामाधिक:
3. D. श्रीमान् धृष्टद्युम्नो—
4. B. सत् for षट्
5. D. सत्कृ(तो) वा मनो हि
6. D. वरणो

Vākya No.	Vākya	Rāśi^r	Bhāga°	Kalā'	Vikalā''
243.	बालेऽभिरुचिरनल्पा[1]	10	26	24	33
244.	स्थिरधीमँहोनायक:	11	8	59	27
245.	स्वनारी रम्यरूपाढ्चा	11	21	22	4
246.	भीमो वलल:	0	3	34	54
247.	शशी नमोमध्ये	0	15	40	95
248.	धीरगीर्मासुरा[2]	0	27	43	29

[इति सङ्गमग्राम्ज-माधव-विरचितानि

विलिप्तादि-चन्द्रवाक्यानि ।][3]

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1. B. बालोऽभिरुचिरं नित्यम् ; D. वलभद्रस्तु प्राश्रिक:

2. D. धरालाभे सुखम्

3. Ms. B carries the following two verificatory verses which set out a method for checking, in case of doubt, the correctness of any Sentence in the above Table :

248
इष्टसंख्योन-'देवेन्द्र'-वाक्यं तत्प्रतियोगिकम् ।
तस्याधऊर्ध्वविवराद् द्विगुणाद्यविवर्जितात् ।।
225
'शिखरा'प्तकलाहीनं प्रतियोग्यं ततस् त्यजेत् ।
इष्टवाक्यं भवेच्छिष्टम् एवं स्याद् वाक्यशोधनम् ।।

Trans.: 248 (devendra) minus the number of the desired (i.e., the doubtful) Sentence is (to be termed) the former's Complementary Sentence (pratiyogika). Take the (two) Sentences above and below it and find their difference. Subtract from this difference twice the Initial Sentence of the Table (viz., śīlam rājñah śriye). Divide this difference by 225 (śikhara) and subtract the quotient from the Complementary Sentence. Subtract the Remainder from the Final Sentence (of the Table, viz., dhīragīr bhāsurā). The result will be

the correct figures of the desired (i e. doubtful) Sentence. This is (stated) the 'Checking of the Sentences'.

Example :

Let the no. of the doubtful Sentence be 50

Complementary Sentence, (248—50)=198

		r	o	′	″
Sentence above Do., *viz.*, 199	=	3	7	9	5
Do. below Do., *viz.*, 197	=	2	11	41	31
Difference			25	27	34
Twice the Initial Sentence, 2×(0-12-2-35) =			24	5	10
Difference			1	22	24
Do. divided by 225, *i.e.*, correction	=				22
Complementary Sentence (198)	=	2	24	18	7
Correction					22
Difference (*i.e.*, Corrected Compl. Sent.) =		2	24	17	45
Final Sentence (248)	=	(12)	27	43	29
Final *minus* Cor. Compl. Sent.	=		10	3	25	44

It may be noted that that the result is the value of the desired 50th Sentence, *viz.*, *bhāve smaro'nganānam syāt*.

In ms. D, in continuation of the *vakyas*, the initial letters (*pratīka-s*), according to this ms., of *vakya* numbers 11, 21, 31 etc. are given, obviously for facilitating recollection :

(11)	(21)	(31)	(41)	(51)	(61)
दुष्टः	कुबेर	च्छन्नो	मनुष्यो	गायत्री	राज्ञाम्

(71)	(81)	(91)	(101)	(111)	(121)
गावः	अ गो	धर्मे	सेव्यो	धनुर्य्या	कठिनो

(131)	(141)	(151)	(161)	(171)	(181)
प्रत्यासन्नः	वाङ्माधुरी	स्तेन	प्रभवः	प्रवृद्धः	पयसि

(191)	(201)	(211)	(221)	(231)	(241)
धनुषा	गौरी	तपस्वी	श्रीमान्	भ्रमर	सूनुः

Ms. D then continues with a verse for checking the correctness of any doubtful Sentence :

248

इष्टसंख्योन-'देवेन्द्र'-वाक्योनान्त्यमिहे(ष्ट)कम् ।
स्वोर्ध्वाधोविवराधिद्विवरात् '(प्रि)यका'प्तयुक् ॥

इतु वाक्यं वहत्तुवान् ।

Trans. : (Sentence number) 248 (*devendra*) *minus* the number of the desired (*i.e.*, doubtful) Sentence (will give the number of the complementary Sentence) : this (Sentence) when subtracted from the Final Sentence will give the (Rough) desired Sentence, (which needs the following correction). Find the difference between the Sentence just above (the desired Sentence) and the one below it, halve his difference and divide by 112 (*priyaka*). Add the quotient to (Rough) desired Sentence (as found above. The result will be the correct desired Sentence). This is (the method) to derive the (doubtful) Sentence.

Example :

    Rough desired Sentence

        Let the no. of the desired Sentence be 50

        248 (*devendra*) *minus* 50   =198

		r	o	'	''
The Final Sentence (248)	=	(12)	27	43	29
Do. *minus* Sentence 198	=	2	24	18	7
Rough desired Sentence	=	10	3	25	22

Correction

		r	o	'	''
Sentence just above (199)	=	3	7	9	5
Do. just below (197)	=	2	11	41	31
Difference			25	27	34
Half of difference			12	43	47
Initial Sentence			12	2	35
Difference				41	12
Divided by 112, *i.e.*, Correction					22

Correct desired Sentence

Correction added to the Rough Sentence	10	3	25	22
	10	3	25	44

It may be noted that this is the 50th Sentence, there *naich'ñṣarkrạm*

syāt.

युगभोगध्रुवाः

5ʳ-10°-7'-40"-48'''   2ʳ-27°-33'-7"-12'''

दिवि नव सानु निकामं, प्रापुः सेना बली सुरा राज्ञः ।

7ʳ-6°-57'-31"-0'''   6ʳ-22°-45'-7"-12'''

अनु किल सम्मतिनाथं, प्राप्य स्थानं शिवारिरतम् ॥ १ ॥

3ʳ-24°-37'-26"-24'''   6ʳ-15°-4'-19"-12'''

वरतरसालभराङ्गं, राज्यं धन्यं भुनज्मि पूतान्नम् ।

1ʳ-4°-30'-43"-12'''   11ʳ-16°-50'-52"-48'''

प्रियगर्भो नगवनकृत्, देवरमौनं मतं कृपया[2] ॥ २ ॥

पादे पादे ज्ञेया युगभोगाः शीतरश्मिमुख्यानाम् ।
पातान्तानामष्टौ यथाक्रमं तत्परादीनि ॥ ३ ॥

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1. These three verses give the zero-corrections, correct to *tat-parā-s* (1/60th of a second) for Moon etc. per *yuga* (aeon, of 2,10,389 days). The verses occur in the *Grahacāranibandhana* (I.17-19) of Haridatta (A.D. 683) the basic manual of the Parahita school of Kerala astronomy (*Ed.* by K.V. Sarma, K.S. Res. Inst., Madras-4, 1954), preceded by the following verses :

अहरात्मकमत्र स्यात् 'धीजगन्नूपुर' (2,10,389) युगम् ॥१२॥

*   *   *

युगभोगध्रुवं कुर्याद् युगमानविवर्धितम् ।
राशिषट्कत्रिकाबिन्दुपातोच्चध्रुवयोर्धनम् ॥१६॥

2. सदा कृपया (corrupt), for मतं कृपया, which latter has been restored from the *Grahacāranibandhana*.

APPENDIX II

ZERO-CORRECTIONS FOR THE AEON

	r	o	′	″	‴
Moon	5	10	7	40	48
Mars	2	27	33	7	12
Mercury	7	6	57	31	0
Jupiter	6	22	45	7	12
Venus	3	24	37	26	24
Saturn	6	15	4	19	12
Moon's Higher Apsis	1	4	30	43	12
Moon's Node	11	16	50	52	48

Foot by foot, (the above verses) are to be understood. as (giving) the Zero-corrections, correct to the *tatparā* (1/60th second), to the planets from Moon to Node, in order, per aeon.

अनुबन्धः ३

कतिचन खण्डाः तदीय-स्फुटचन्द्रध्रुवाश्च

'मनसा शम्भुः स्तुत्यः' 'स्वर्गार्थी लोक ईशानात्' ।
'लोलो गङ्गाम्बुचयो' 'भद्रा धीर्भोगिनाथानाम्' ॥ २ ॥

'पाताळेन श्रुतयो' 'भाग्यं ध्यानार्चनाधीनम्' ।
'धीजो मदनश्चापी' 'भानुर्गोपो जनैः पूज्यः' ॥ २ ॥

'मोहाधिक्यं प्रणयात्' 'क्षोणीशोऽल्ं गुरोर्ध्यानी' ।
'स्त्रीसङ्गः प्रीत्यै नो' 'नित्यं दैवं स्थिरं धेनौ' ॥ ३ ॥

'भद्राकारा इयेना' 'कविवग् ज्ञानी नळो नूनम्' ।
'गोलो नढोऽनेन' 'व्यालोलाङ्गः खराधीनः' ॥ ४ ॥

'प्रीतोऽनन्तः ज्ञानी' 'काष्ठा रत्नांशुकानां का' ।
'योगी नो गानज्ञो' 'नित्यं पिण्डार्थिनः काकाः' ॥ ५ ॥

'तीर्थं धारा नूनम्' 'भवेत् पवित्रं न पापानाम्' ।
'होरासारः ज्ञानी' 'शोच्यो हिमवाननुद्यानः' ॥ ६ ॥

'इन्दुर्भद्रो नूनम्' 'सर्वे विद्यार्थिनो धनिनः' ।
'रङ्गं रुद्रो नग्नो' 'दिव्यो योगी धनैर्हीनः' ॥ ७ ॥

'वैदग्धी यज्ञे रज्ञा' 'धन्वी सेवापटुः सूनुः' ।
'चण्डः सम्पन्नो ना' 'पुरभिन्नैवाच्यंतेऽज्ञेन' ॥ ८ ॥

'देही विद्या नूनम्' 'श्रीमानिन्द्रस्तपोमानी' ।
'नीवी रम्या नूनम्' 'गौरी साम्बा जपाभा नु' ॥ ९ ॥

'श्रद्धाधीनं ज्ञानम्' 'जीर्णा गीर्मेऽनुरागीना' ।
'विष्वक्सेनो ज्ञानी' 'क्षेत्रज्ञोऽयं गुरुः प्राज्ञः' ॥ १० ॥

'स्तब्धा वाङ् नो ज्ञानं' 'सोमस्तरुणप्रियो नूनम्' ।
'देवः प्राज्ञो नूनं' 'धीरोऽल्ं भासुरो ज्ञानी' ॥ ११ ॥

श्लोकदलाद्ये पादे त्यक्तव्यो दिनगणः समुद्दिष्टः ।
विकलाद्यः स्फुटचन्द्रस्तदीयभाजो ध्रुवा द्वितीयेऽस्मिन् ॥ १२ ॥

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APPENDIX III

SOME LUMP DAYS AND THEIR TRUE-MOON-ZERO-CORRECTIONS

Lump Days	Zero-Corrections			
	$R\bar{a}\acute{s}i^r$	$Bh\bar{a}ga^\circ$	$Kal\bar{a}'$	$Vikal\bar{a}''$
16,45,705	5	1	37	34
16,33,333	7	3	49	24
16,20,961	9	6	1	14
16,08,589	11	8	13	4
15,21,985	1	23	35	56
12,372	9	27	48	10
12,124	9	0	4	41
9093	9	22	33	31
6062	10	15	2	21
3031	11	7	31	11
2976	11	2	41	44
2728	10	4	58	15
2481	9	7	14	47
2232	8	9	31	18
1984	7	11	47	49
1736	6	14	4	21
1488	5	16	20	52
1240	4	18	37	23
992	3	20	53	58
744	2	23	10	26
496	1	25	26	57
248	0	27	43	29

In the first part of each half-verse, the number of days to be deducted are indicated. And, in the second part, the True Moon, being (also) the corresponding Zero-correction, correct to the second (*vikala*), has been indicated.

स्फुटचन्द्राप्तिः

श्लोकार्धानुक्रमणिका